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Type VM 715

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REFLECTOSCOPES

And Accessories

OPERATING & MAINTENANCE MANUAL

SPERRY PRODUCTS

DIVISION OF AUTOMATION INDUSTRIES, INC.

TYPE UM 715 AND UM 721

REFLECTOSCOPES

And Accessories

OPERATING & MAINTENANCE
MANUAL

A DIVISION OF AUTOMATION INDUSTRIES, INC.

TABLE OF CONTENTS

	Page No.
SECTION I - INTRODUCTION AND GENERAL EQUIPMENT DESCRIPTION	1-1
1. GENERAL	1-2
a. MECHANICAL SPECIFICATIONS	1-2
b. ELECTRICAL SPECIFICATIONS	1-3
2. DISPLAY/TIMER UNIT	1-3
a. MAJOR COMPONENTS	1-3
3. PULSER/RECEIVER UNIT	1-4
a. MAJOR COMPONENTS	1-4
b. SPECIFICATIONS	1-5
c. MODIFICATIONS	1-5
4. ACCESSORY UNITS FOR UM 721	1-6
SECTION II - PRINCIPLE OF REFLECTOSCOPE OPERATION	2-1
1. GENERAL	2-1
2. FREQUENCIES EMPLOYED	2-1
3. SEARCH UNIT OPERATION	2-1
a. GENERAL	2-1
b. ULTRASONIC PULSES	2-3
c. MODE OF VIBRATION	2-3
d. REFLECTION	2-5
e. REFRACTION AND MODE CONVERSION	2-5
f. FREQUENCY	2-6
g. BEAM DIVERGENCE	2-6
h. SIZE OF SEARCH UNIT CRYSTAL	2-7
i. COUPLANT	2-7
j. SEARCH UNITS	2-8
4. VISUAL PRESENTATION	2-13
a. SWEEP	2-13
b. INDICATIONS	2-13
c. MARKERS	2-13
5. REFLECTOSCOPE TIMING	2-15
a. SWEEP DELAY	2-16
b. SWEEP LENGTH	2-17
c. INTERFACE SYNC	2-19
d. TRANSIGATE SYSTEM	2-20
e. MEASUREMENT OF DISTANCE IN MATERIALS	2-21
f. PULSE REPETITION RATE	2-22

Page No.

SECTION III - FAMILIARIZATION 3-1

BASIC TRAINING PROCEDURE 3-1
1. SET UP PROCEDURE 3-1
a. PREPARATION FOR USE 3-1
2. FAMILIARIZATION 3-2
a. DISPLAY/TIMER UNIT 3-2
b. PULSER/RECEIVER UNIT 3-3
c. TESTING 3-3
3. FAMILIARIZATION - DETAIL 3-4
a. PULSER/RECEIVER 3-4
b. DISPLAY/TIMER UNIT 3-5
4. ANGLE BEAM TESTING TECHNIQUE (CONTACT) . 3-9
5. THROUGH-TRANSMISSION 3-12
6. SINGLE SEARCH UNIT IMMERSION TESTING . . . 3-16
7. THROUGH-TRANSMISSION IMMERSION TESTING . 3-22

SECTION IV - DISPLAY/TIMER UNIT 4-1

1. GENERAL 4-1
a. POWER SUPPLY. 4-1
b. DEFLECTION AMPLIFIER BOARD 4-2
c. HIGH VOLTAGE BOARD 4-2
d. CATHODE RAY TUBE 4-2
e. TIMER BOARD 4-2
2. FRONT PANEL CONTROLS 4-2
a. DISPLAY 4-2
b. TIMING 4-3
3. INTERNAL CONTROLS 4-5
a. POWER SUPPLY CHASSIS 4-5
b. DEFLECTION AMPLIFIER BOARD 4-6
c. TIMING BOARD 4-6
4. CIRCUIT DESCRIPTION. 4-7
a. POWER SUPPLIES. 4-7
b. VERTICAL FINAL AMPLIFIERS 4-8
c. HORIZONTAL FINAL AMPLIFIERS 4-8
d. TIMER BOARD 50D349 4-8

Page No.

TROUBLESHOOTING CHARTS 4-11
DEFLECTION AMPLIFIER BOARD 50C770 DC VOLTAGE CHART 4-23
HIGH VOLTAGE BOARD 50C771 DC VOLTAGE CHART . . 4-24
POWER SUPPLY DC VOLTAGE CHART 4-25
TIMER BOARD 50D352 DC VOLTAGE CHART 4-26
WAVEFORM CHARTS 4-27
PARTS LIST 4-35

SECTION V - ACCESSORY UNITS FOR UM-721 5-1

GENERAL 5-1
TRANSIGATE - STYLE 50E550 5-1
UT GAGE - STYLE 53B137 5-2
DISTANCE AMPLITUDE CORRECTION UNIT - STYLE 50E551 5-3

SECTION VI - PULSER/RECEIVER UNITS 5B, IN, 2.25N, 5N 10N AND HFN, 5NRF 6-1

DESCRIPTION . . . . . .
1. GENERAL 6-1
a. TRIGGER AMPLIFIER 6-4
b. PULSER 6-4
c. TIMER DELAY AND HIGH VOLTAGE CIRCUIT. . . 6-4
d. RF AMPLIFIER. 6-4
e. FREQUENCY SELECTOR 6-4
f. TUNING CIRCUIT BOARD (HFN UNIT ONLY). . . . 6-4
g. VIDEO DETECTOR 6-4
h. LIMITER AND OUTPUT CIRCUIT. 6-4
2. MECHANICAL SPECIFICATIONS 6-4
a. PULSER CONTROLS 6-5
b. GAIN CONTROLS 6-5
c. VIDEO CONTROLS 6-5
d. FREQUENCY CONTROLS 6-5
e. TEST CONTROLS. 6-5
f. RECEPTACLES 6-5
3. ELECTRICAL SPECIFICATIONS 6-5

Page No.

OPERATION
1. FUNCTION OF CONTROLS 6-6
a. PULSER CONTROLS 6-6
b. GAIN CONTROLS 6-6
c. VIDEO CONTROL 6-6
d. FREQUENCY CONTROLS 6-7
e. TEST CONTROLS 6-7
f. RECEPTACLES 6-7
2. FAMILIARIZATION 6-8
a. FAMILIARIZATION - GENERAL 6-8

PRINCIPLES OF OPERATION
1. GENERAL 6-9
2. DETAILED THEORY 6-12
MODEL 5NRF 6-17
1. GENERAL 6-17
2. CIRCUIT DESCRIPTION 6-17
MODIFICATIONS 6-18
1. GENERAL 6-18
2. PROCEDURE 6-18
WAVEFORM CHARTS 6-19
PARTS LIST 6-21

SECTION VII - DISTANCE AMPLITUDE CORRECTION (DAC) UNIT 7-1
DESCRIPTION
1. GENERAL 7-1
FIGURE 7-1 7-2
2. MECHANICAL SPECIFICATIONS 7-3
3. ELECTRICAL SPECIFICATIONS 7-3
OPERATION
1. FUNCTION OF CONTROLS 7-3
a. TIMING CONTROLS 7-3
b. WAVE GENERATOR CONTROLS 7-4
c. SYNC (2 POSITION SWITCH) 7-4
d. MODE(3 POSITION SWITCH) 7-4
2. FAMILIARIZATION 7-4
a. SET-UP 7-4
b. GENERAL 7-4
c. DETAIL 7-5
3. TESTING 7-7

Page No.

4. PRINCIPALS OF OPERATION 7-9
a. SYSTEM DESCRIPTION 7-9
CALIBRATION PROCEDURE
1. SET-UP PROCEDURE 7-10
2. DAC - DISPLAY D. C. LEVEL ADJUSTMENT 7-10
3. DAC - RECEIVER D. C. LEVEL ADJUSTMENT . . . 7-11
4. DAC CALIBRATION 7-12
CIRCUIT DESCRIPTION
1. TIMING BOARD, 50C697 7-13
a. GENERAL 7-13
b. MAIN PULSE TRIGGER 7-13
c. I. F. PULSE TRIGGER 7-14
d. START ONESHOT 7-14
e. LENGTH ONESHOT 7-14
f. COMPLEMENTARY SYMMETRY DRIVER 7-15
g. POSITIVE SLOPE GENERATOR. 7-15
h. NEGATIVE SLOPE GENERATOR 7-15
2. COMPENSATING AMPLIFIER BOARD, 50C698 . . . 7-15
a. GENERAL 7-15
b. DRIVER E.F. 7-15
c. COMPENSATING NETWORK 7-16
d. D.C. LEVEL SHIFTERS 7-16
e. RECEIVER E.F. 7-16
f. DISPLAY E.F. 7-16
3. MAINTENANCE 7-17
a. GENERAL 7-17
WAVEFORM CHARTS 7-18

SECTION VIII - TYPE UM 710 SPECIAL FUNCTION
CABINET 8-1

DESCRIPTION
1. GENERAL 8-1
2. TYPICAL APPLICATION 8-2
PARTS LIST 8-6

SECTION IX - TRANSIGATE STYLE 50E550 9-1

DESCRIPTION
1. GENERAL 9-1

Page No.

a. ECHO GATE 50C384 9-2
b. RECORDER BOARD 50C385. 9-2
c. ALARM BOARD 50C386 9-2
d. INTERFACE OR FIRST ECHO SYNC 50C387 9-2
e. FRONT AND REAR PANEL ASSEMBLY 9-3
2. MECHANICAL SPECIFICATIONS. 9-3
a. GATE CONTROLS 9-3
b. ALARM CONTROLS 9-3
c. SYNC CONTROLS 9-3
3. ELECTRICAL SPECIFICATIONS 9-3
4. GATES 9-4
5. RECORDING SIGNALS 9-4
6. RANGE OF LEVEL CONTROL. 9-4
7. OPERATING TEMPERATURE RANGE 9-4
OPERATION
1. FUNCTION OF CONTROLS 9-4
a. GATE CONTROLS 9-4
b. ALARM CONTROLS 9-5
c. SYNC CONTROLS 9-6
2. FAMILIARIZATION 9-7
a. SET-UP 9-7
b. FAMILIARIZATION - GENERAL 9-7
c. FAMILIARIZATION - DETAIL 9-7
d. TESTING 9-9
PRINCIPLES OF OPERATION
1. GENERAL 9-9
2. ECHO GATE 50C384 9-10
3. RECORDER BOARD 50C385 9-12
4. INTERFACE OR FIRST ECHO SYNC 50C387. 9-16
5. ALARM BOARD 50C386 9-18
MAINTENANCE . . . . . .
1. GENERAL 9-20
a. TEST AND ASSOCIATED EQUIPMENT 9-20
2. TRANSIGATE 50E550 CHASSIS INSPECTION AND MEASUREMENT 9-20
PARTS LIST - TRANSIGATE UNIT STYLE 50E550 9-23

SECTION X - TYPE S RECORDING AMPLIFIER 10-1

DESCRIPTION
1. GENERAL 10-1
a. RELAY 10-1
b. CONTROL RELAYS 10-2
c. ALFAX PRINTING CHANNEL. 10-2
d. POWER SUPPLY AND REGULATOR 10-2
e. SWITCH OR PENMOTOR AMPLIFIER 10-2

Page No.

2. SPECIFICATIONS 10-2
a. GENERAL FEATURES 10-2
b. POWER REQUIREMENTS 10-3
OPERATION
1. FUNCTION OF CONTROLS 10-3
a. ALFAX-SOLENOID 10-3
b. PENMOTOR 10-3
c. ALFAX INTENSITY 10-3
d. PENMOTOR RANGE 10-3
2. FAMILIARIZATION 10-3
a. SET UP 10-3
b. FAMILIARIZATION - DETAIL 10-8
PRINCIPLES OF OPERATION
1. GENERAL 10-8
2. POWER SUPPLY & REGULATOR 10-10
3. CHANNEL A OR B OPERATED IN THE ALFAX RECORDING MODE 10-10
4. CHANNEL A OR B OPERATED AS SOLENOID DRIVER 10-11
5. CHANNEL A OR B OPERATED AS PENMOTOR AMPLIFIER 10-12
6. RELAY OUTPUT 10-12
PARTS LIST 10-14

SECTION XI - TYPE R RELAY CHASSIS 11-1

DESCRIPTION
1. GENERAL 11-1
a. POWER ON-OFF RELAY 11-2
b. TRANSFORMER 11-2
c. CONTROL RELAYS 11-2
d. OUTPUT CONNECTOR 11-2
2. SPECIFICATIONS 11-2
a. GENERAL FEATURES 11-2
b. PENMOTOR SIGNAL OUTPUT CHARACTERISTICS 11-2
c. ALFAX SIGNAL OUTPUT CHARACTERISTICS . . 11-2
d. POWER REQUIREMENTS 11-2
OPERATION
1. FAMILIARIZATION 11-3
a. SET-UP 11-3
b. FAMILIARIZATION 11-3
PRINCIPLES OF OPERATION
1. GENERAL 11-3
2. CIRCUIT OPERATION 11-6
PARTS LIST 11-8

SECTION XII - TRANSIGRAPH

	Page No.
DESCRIPTION	
1. GENERAL	12-1
2. MECHANICAL SPECIFICATIONS	12-2
3. ELECTRICAL SPECIFICATIONS	12-2
4. PERFORMANCE SPECIFICATIONS	12-2
OPERATING INSTRUCTIONS	
1. FUNCTION OF CONTROLS	12-3
a. CALIBRATED INPUT	12-3
b. LIMIT ADJUSTS	12-3
c. INTENSITY	12-3
d. OUTPUT	12-3
e. SETUP-OPERATE SWITCH	12-3
2. SETUP - GENERAL	12-3
a. FRONT CONNECTIONS	12-3
b. REAR CONNECTIONS	12-3
3. SETUP - DETAIL	12-3
4. SETUP (USING SIMULATED SIGNALS PROVIDED BY TRANSIGRAPH)	12-4
PRINCIPLES OF OPERATION	
1. CONDITION (SETUP-OPERATE SWITCH IN SETUP POSITION)	12-5
2. CONDITION (SETUP-OPERATE SWITCH IN OPERATE POSITION)	12-6
3. CONDITION (PLUS-MINUS SWITCH IN MINUS POSITION)	12-6
4. TYPICAL VOLTAGE READINGS	12-7
MAINTENANCE	
1. GENERAL	12-8
a. TEST AND ASSOCIATED EQUIPMENT	12-8
2. TRANSIGRAPH 50E543	12-9
BLOCK DIAGRAM	12-10
PARTS LISTS	12-11

SECTION XIII - THICKNESS READOUT UNIT

	Page No.
DESCRIPTION	13-1
1. GENERAL	13-1
2. MECHANICAL SPECIFICATIONS	13-1
3. ELECTRICAL SPECIFICATIONS	13-1
4. PERFORMANCE SPECIFICATIONS	13-1
a. ACCURACY	13-1
b. SCALE EXPANSION	13-1
c. RANGE	13-1
d. TEST MODE	13-2
e. GATE RANGE	13-2
OPERATING INSTRUCTIONS	13-2
1. SETUP - GENERAL	13-2
a. FRONT CONNECTIONS	13-2
b. REAR CONNECTIONS	13-2
2. SETUP - DETAIL	13-2
3. COMMENTS	13-3
PRINCIPLE OF OPERATION	13-4
1. GATE AND RAMP GENERATOR BOARD	13-4
2. RECORD BOARD	13-4
3. ALARM AND AMPLIFIER BOARD	13-4
MAINTENANCE	13-5
1. GENERAL	13-5
a. TEST AND ASSOCIATED EQUIPMENT	13-5
b. VOLTAGE MEASUREMENT	13-5
c. WAVE FORMS	13-5
WAVE FORM CHARTS	13-7
PARTS LIST	13-11

Type UM 727 Ultrasonic Reflectoscope

Type UM 729 Ultrasonic Reflectoscope

Figure 1-1

SECTION I

INTRODUCTION AND GENERAL EQUIPMENT DESCRIPTION

The Type UM 715 and 721 Reflectoscopes are instruments for non-destructive testing of materials through the use of ultrasonic methods. Ultrasonic inspection is generally applied to three classes of material inspection:

1. Locating internal or surface discontinuities or inhomogeneities in materials.

2. Determining the differences in structure and physical properties.

3. Measuring the thickness of material from one side.

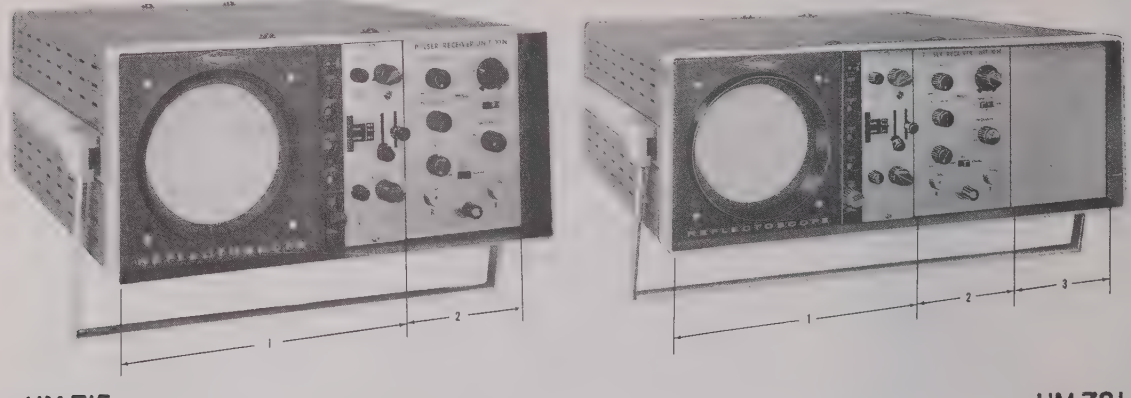
The UM Series Reflectoscopes are visually interpreted ultrasonic instruments for both contact and immersion testing with either single or two search unit techniques. Alarm and recording systems may be added for monitoring tests at production speeds.

1. GENERAL

The Type UM Reflectoscopes are designed to provide a maximum flexibility through the use of interchangeable plug-in units. They permit an economical building block method of selecting only those units necessary for a specific testing job. The basic instrument consists of a Display/Timer Unit and a Pulser/Receiver plug-in unit.

The UM 715 is intended for use where interpretation is visual and no accessory functions are required, or planned for the future. Small size and weight are desirable features of the UM 715.

The UM 721 is intended for use where more than a basic ultrasonic test is required. Provision is made within the case for plugging one accessory unit directly into the basic unit. The particular accessory may be selected to complement the Display/Timer and Pulser/Receiver units to perform specific tests. The performance of the UM 715 and UM 721 are identical in the basic version. The same quality and accuracy of tests will be obtained by using either the UM 715 or the UM 721.



UM 715 UM 721

1. DISPLAY/TIMER 2. PULSER/RECEIVER 3. ACCESSORY UNIT

Figure 1-2

a. MECHANICAL SPECIFICATIONS

(1) The instrument frame is made up of self-supporting clear anodized aluminum members and is covered with a removable grey vinyl-clad aluminum skin. The vinyl is impervious to oil and the majority of commercial solvents. It has a high degree of resistance to scuffing and abrasions.

(2) Rubber foot-knobs at the four corners of the instrument bottom and back, permit positioning in either upright or horizontal positions.

(3) Fuses and power connections are located in the recessed instrument back.

(4) The Display/Timer unit is an integral part of the instrument frame. The Pulser/Receiver plug-in unit slides in and out on aluminum channel frame members and is locked in position by a knob controlled cam. Other accessory units for the UM 721 are plugged in similarly.

(5) Cooling fan - provides filtered, forced air ventilation assuring proper operating temperature for all components.

(6) The UM 721 Reflectoscope measures 7" high x 20 1/4" wide x 19 7/8" deep. Weight is approximately 43 lbs. The UM 715 Reflectoscope measures 7" high x 15 3/4" wide x 20" deep. Weight is approximately 38 lbs.

(7) The UM 721 has an accessory plug-in space which accepts any standard accessory, such as Transigate, DAC and T-Gage. Refer to Section VI. Provision is also made for further use of accessories by adding the UM 710 Special Function Chassis. Refer to Section VIII.

b. ELECTRICAL SPECIFICATIONS

(1) Power requirements - 115V ± 10V, 50/60 cycle single phase, 230 watts.

(2) The Display/Timer unit provides all power required for the Display/Timer and Pulser/Receiver components. All DC supplies and voltages to the CRT are regulated.

2. DISPLAY/TIMER UNIT (Figure 1-3)

a. MAJOR COMPONENTS

Power Supply
Timer Board
High Voltage Board
Deflection Amplifier
Cathode Ray Tube

(1) Power Supply - furnishes the voltages needed to operate the various electronic tubes and the cathode ray tube. Power supplies for the Pulser/Receiver and Timer sections are also contained in the Display/Timer unit.

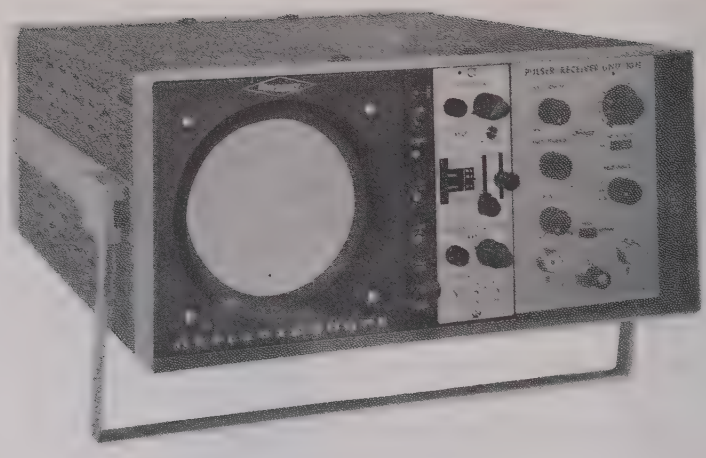


Figure 1-3

(2) Timer Board - A plug-in circuit which is the main timing source for all functions. It generates sweep, sweep delay and marker signals for CRT, and sync signal to initiate the main bang in the Pulser/Receiver.

(3) High Voltage Board - a plug-in circuit supplying high voltage to the CRT and unblanking amplifier.

(4) Deflection Amplifier - a plug-in circuit which amplifies the voltage supplied to the CRT deflection plates.

(5) Cathode Ray Tube - 5" flat-faced CRT. The vertical indications of the initial pulse delivered to the search unit and all echo signals received by the search unit are displayed on a horizontal time base line. A separate horizontal trace is used for display of square wave markers. Edge lighted scribed screen contributes to easier viewing and reading of signal pattern amplitudes.

3. PULSER/RECEIVER UNIT (Figure 1-4)

a. MAJOR COMPONENTS
Echo Pulse Amplifier
Video Detector
Pulser

(1) Echo Pulse Amplifier (for particular frequency ranges and operating characteristics, refer to Section VI). Receives both outgoing pulses from the pulse generator and incoming pulses from the search unit and amplifies them for transmission to the Video Detector

(2) Video Detector - converts radio frequency signals from Echo Pulse Amplifier to unidirectional video which is filtered to give clear smooth indications.

(3) Pulser - receives synchronization signal from Timer unit. Sends out short repetitive bursts of high frequency pulses to the search unit; receives and amplifies echoes returned by the search unit.

b. SPECIFICATIONS

(1) Mechanical - unit plugs into the UM instrument frame and is locked in position by a knob controlled cam. It is easily disconnected for service and interchange.

(2) Electrical - all power required is supplied from the UM Display/Timer unit.

c. ACCESSORY UNITS FOR UM 721

Addition of any standard UM accessory without modification is possible by merely plugging into accessory space in UM 721. Such standard accessories as Transigate with gate, alarm, recording output and interface sync; DAC for distance amplitude correction of pulser/receiver sensitivity; and UT-Gage for meter readout thickness measurement may be used. Refer to Section V for further information.

SECTION II

PRINCIPLE OF REFLECTOSCOPE OPERATION

1. GENERAL

The purpose of this section is to present a brief introduction to the ultrasonic Reflectoscope method of nondestructive testing. The subject is covered extensively in Volume 2 of the Nondestructive Testing Handbook, compiled by the Society for Nondestructive Testing and published by the Ronald Press Company, 15 East 26th Street, New York 10, N. Y.

2. FREQUENCIES EMPLOYED

Ultrasonic inspection utilizes high-frequency mechanical vibrations for nondestructive testing of materials. Most commercial ultrasonic testing is done at frequencies between 0.2 and 25 megacycles per second. However, applications exist for frequencies as low as 25 kilo cycles and as high as 200 megacycles.

These high frequency mechanical vibrations are similar to sound waves but far beyond the audible range and are waves of particle vibration. They are rapidly attenuated in air or gasses and travel best in most liquids and solids. Important characteristics of these ultrasonic vibrations are:

a. They may travel long distances through materials.

b. They travel in well-defined beams.

c. The velocity of the vibrational wave is a constant through a given material.

d. Temperature variation over wide limits has little effect on the velocity of the vibrational wave.

e. Vibrational waves will be reflected at discontinuities or boundaries of different elastic and physical properties.

f. They will change their mode of vibration under certain conditions, as at interfaces of materials having different elastic and physical properties or when reflected from boundaries.

3. SEARCH UNIT OPERATION

a. GENERAL

The heart of an ultrasonic testing system is the method of transforming electrical pulses into mechanical vibrations, and transforming the mechanical vibrations back into electrical pulses. This

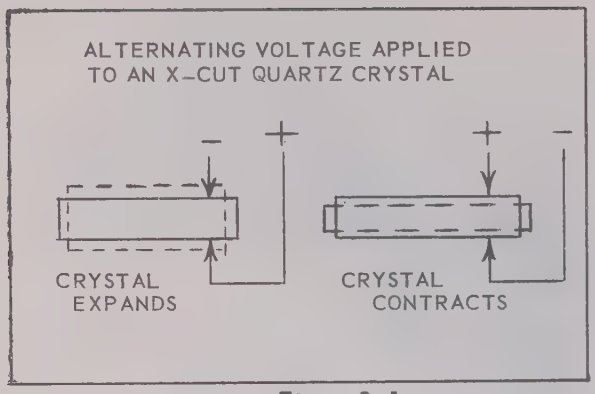


Figure 2–1
Generation of Ultrasonic Vibrations

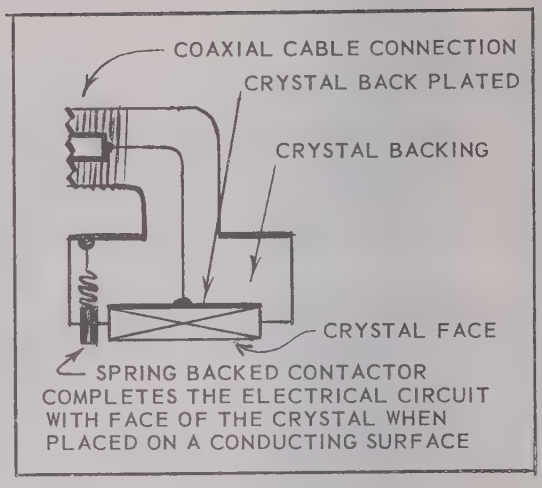


Figure 2–2
Typical Search Unit

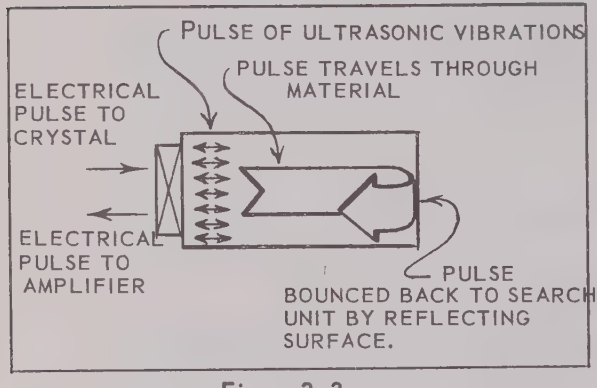


Figure 2–3
The use of the pulse system of Ultrasonic Testing.

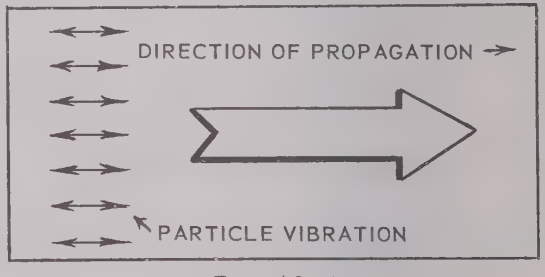


Figure 2–4
Longitudinal Waves.

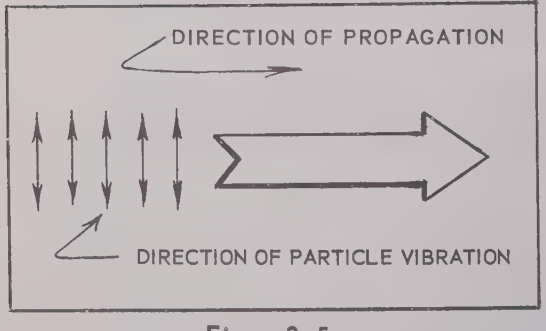


Figure 2–5
Shear Waves

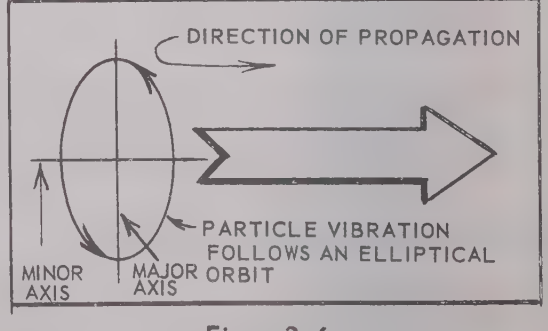


Figure 2–6
Surface Waves

transformation may be accomplished by a number of substances possessing the piezoelectric characteristics; most common substances used for this purpose are quartz, lithium sulphate, barium titanate and lead zirconate.

If an electrical pressure or voltage is applied across a crystal, its thickness will vary as the frequency of the applied voltage (Figure 2-1). Conversely, if mechanical pressure is exerted on the face of the crystal, it will generate a small voltage of the same frequency as the applied mechanical vibration. The assembly holding the crystal is referred to as a "Search Unit" (Figure 2-2).

b. ULTRASONIC PULSES

Generation of the ultrasonic pulse is accomplished by producing a radio frequency pulse of the desired frequency at a precise time, then converting the pulse into ultrasonic vibrations by means of a piezoelectric crystal. The crystal is actuated for a controllable period of time (about 2 millionths of a second or less) resulting in a short burst of sound waves. The pulse travels through the material to the opposite boundary where it is reflected back to the source as an echo. After the crystal has given off this short burst of vibrations, it stops vibrating for a period long enough to receive the returning echoes (Figure 2-3). This cycle of transmitting and receiving is repeated at a rate of 60 or more times per second, according to the type of Reflectoscope used.

c. MODE OF VIBRATION

There are many wave forms and modes of ultrasonic vibrations which will travel through metals. The most important of these are:

(1) Longitudinal (Compressional) Waves, with particle vibration in the direction of propagation. These are similar to audible sound waves, which are also compressional in character (Figure 2-4).

(2) Shear (Transverse) Waves, with particle vibration transverse to the direction of wave travel. The velocity of shear waves is approximately half of that of longitudinal waves (Figure 2-5)

(3) Surface (Rayleigh) Waves travel with little attenuation in the direction of propagation, but their energy decreases rapidly as the wave penetrates below the surface. These waves are confined to a narrow region on and just below the surface. The particle displacement of the wave motion follows an elliptical orbit in which the major axis of the ellipse is perpendicular to the surface and the minor axis is parallel to the direction of propagation. (Figure 2-6).

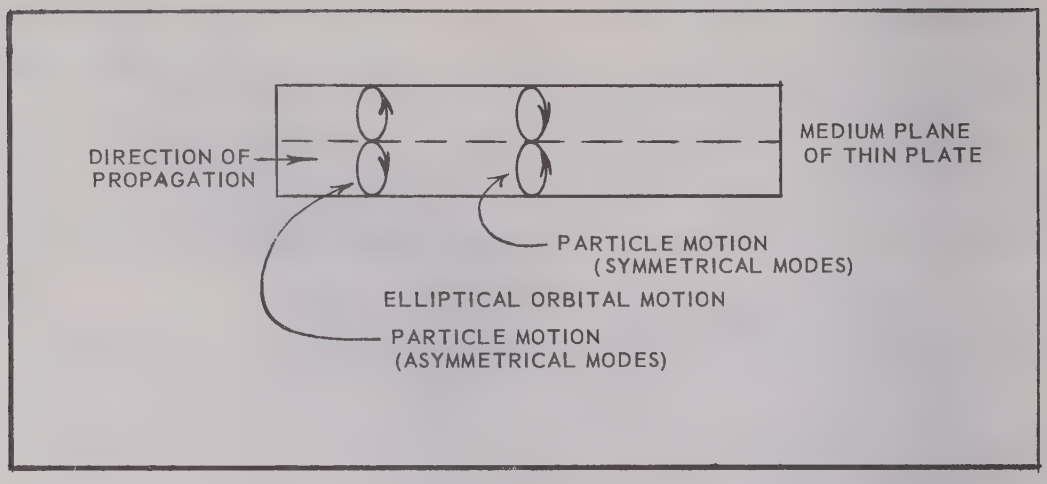


Figure 2–7
Lamb Waves Propagation

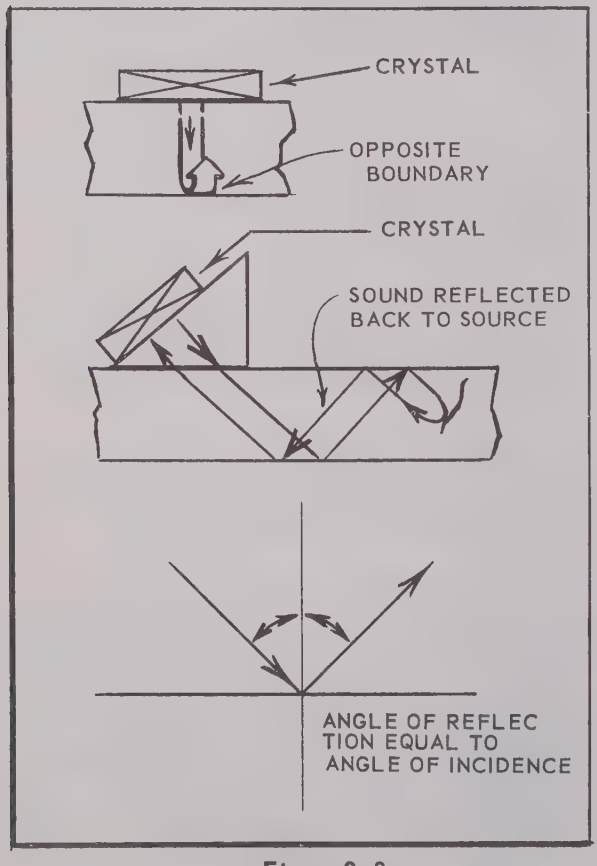


Figure 2–8
Reflection of the Ultrasonic Beam

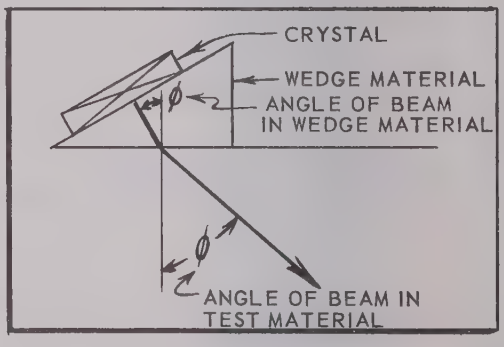


Figure 2–9
Refraction of the Ultrasonic Beam

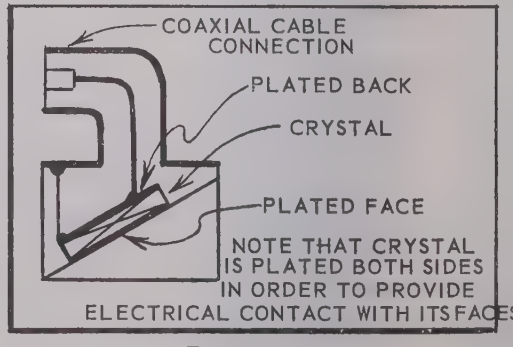

COAXIAL CABLE CONNECTION
PLATED BACK
CRYSTAL
PLATED FACE
NOTE THAT CRYSTAL IS PLATED BOTH SIDES IN ORDER TO PROVIDE ELECTRICAL CONTACT WITH ITS FACE

Figure 2–10
Angle Beam Search Unit

(4) Lamb Waves can exist in two types and many possible modes. The particle motion of the two types, symmetrical and asymmetrical, are illustrated in Figure 2-7. The velocity of propagation (phase velocity) is dependent upon the frequency, the thickness of material and the group or bulk longitudinal velocity of the material.

d. REFLECTION

Reflection of the ultrasonic vibrations will occur at the boundary between two different materials. The ultrasonic beam can be compared to a beam of light traveling through space and being reflected from a number of mirrors (Figure 2-8). The path traveled and the return of the beam to its source, depends upon the angles at which it impinges upon the reflecting surfaces, as well as the number and locations of of these surfaces.

e. REFRACTION AND MODE CONVERSION

Refraction and mode conversion of the ultrasonic beam when passing at an angle from one material to another is comparable to the refraction of light beams when passing from one medium to another (Figure 2-9). Reflection, at certain angles from an interface, will also cause a mode conversion of the ultrasonic beam.

The search unit usually used to introduce an ultrasonic beam at an angle into metals under inspection, consists of a plastic wedge of suitable material on which the crystal is mounted, as in Figure 2-10. If the velocities in the wedge material and the test material are different, the longitudinal vibrations will be refracted when passing into the test material. At certain angles conversion to other modes of vibration, such as shear (Figure 2-11) and surface waves (Figure 2-12), occurs, provided the ratio of velocities is substantially greater than one. The following formula may be used to calculate

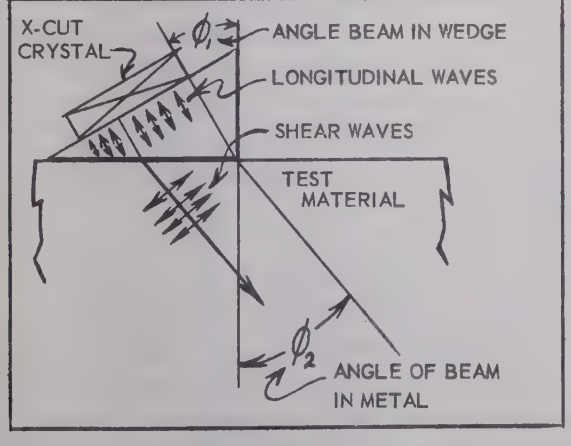


Figure 2-11
Generating Shear Waves in Metals

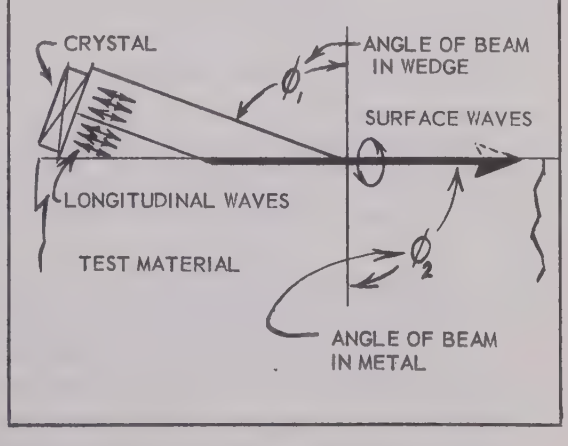


Figure 2-12
Generating Surface Waves

the wedge angle, resultant inspection angle, and mode of conversion for any combination of materials including water, oil or other fluids when used for immersion testing:

$$\frac{\text{Sin } \emptyset 1}{\text{Sin } \emptyset 2} = \frac{V1}{V2}$$

where $\emptyset 1$ = angle from normal of the beam in the wedge or liquid.
$\emptyset 2$ = angle of refracted beam in metal.
$V 1$ = velocity of incident vibrations in the wedge or liquid (usually the longitudinal velocity)
$V 2$ = velocity of vibrations in the material under inspection.

ANGLE Ø 1	ANGLE Ø 2			
Wedge Angles for Plastic	Angles of Transmission for Steel			
	LONGITUDINAL	SHEAR	SURFACE	USEFUL MODE OF VIBRATION
0–15	0–35	0–18	NONE	LONGITUDINAL
15–27	35–90	18–33	NONE	LONG & SHEAR
27–56	NONE	39–90	NONE	SHEAR
60–70	NONE	NONE	90	SURFACE

TABLE 1. Angle of Refraction and Change of Mode of Vibration in Steel using a Plastic Wedge.

f. FREQUENCY

In practical testing, selection of frequency depends on sensitivity desired and sound penetration required: high frequency for sensitivity and low frequency for penetration.

In general, sound waves of all frequencies will penetrate fine grain material to approximately the same depth. However, as the grain structure becomes more coarse, interference in the form of scattering may be expected when using higher frequencies (shorter wave lengths), and greater depth of penetration will be obtained by going to a lower frequency (longer wave length).

g. BEAM DIVERGENCE

Figure 2-13 illustrates the beam divergence of the sound waves travelling through steel and how this beam divergence varies with frequency and crystal diameter. The higher frequencies are more directive, and a 1-inch diameter crystal at any frequency is more directive than a 1/2-inch diameter crystal. In ultrasonic testing, beam divergence is usually expressed in inches per foot, rather than angular degrees.

h. SIZE OF SEARCH UNIT CRYSTAL

The amount of sound energy transmitted into the material depends upon the size of the crystal. Thus, it is sometimes advisable to use a larger crystal to obtain a greater depth of penetration.

i. COUPLANT

Actual movement of crystal vibration is infinitesimal; it is often described as accelleration without motion. To transmit such a small amount of energy into a material, it is necessary to use a couplant between the quartz face and the material surface. A film of oil, glycerine or water is generally used as a couplant in contact testing (Figure 2-14). In immersion testing, both the search unit and the material are immersed in transmitting liquid, usually water. (Figure 2-15).

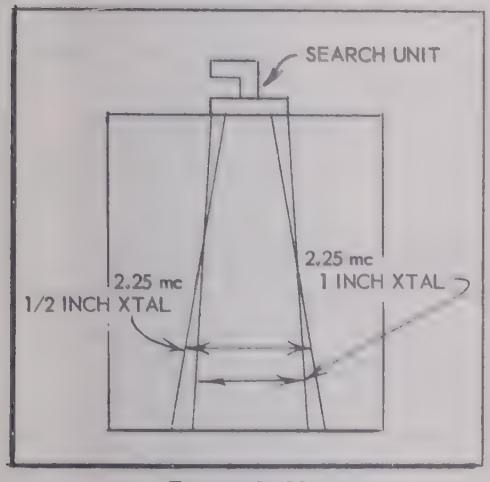


Figure 2–13
Beam Divergence in Steel

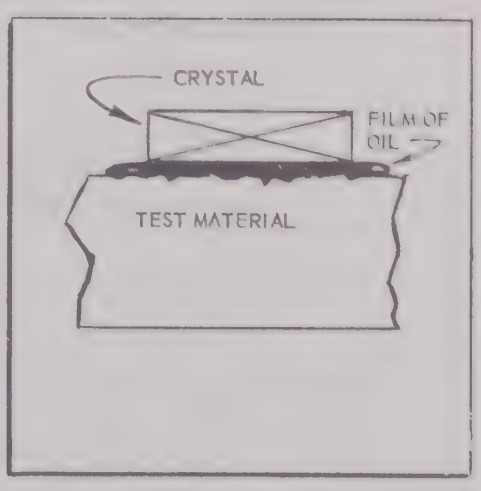


Figure 2–14
Couplant for Contact Testing

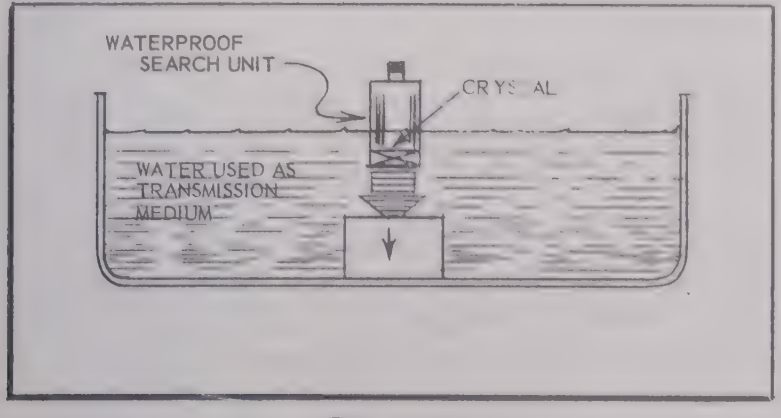


Figure 2–15
Couplant for Immersion Testing

j. SEARCH UNITS

Sperry search units are available in various styles and types to meet requirements for a large range of applications. These search unit types fall roughly into four groups, straight beam search units for contact testing, angle beam search units for contact testing, surface wave search units for contact testing and immersion search units (waterproof).

(1) Straight Beam Search Units (Contact) - this type of search unit projects a beam of ultrasonic vibrations perpendicular to the test surface. It can be used for either the reflection (echo) technique or the through transmission technique.

(a) Reflection Technique (Echo) - the reflection or echo technique can be performed with either the single or the two search unit method as follows:

1) Single search unit reflection technique - the search unit acts as both transmitter and receiver. It projects a beam of longitudinal waves into the material under test and receives echoes reflected back to it from the opposite boundary and from any discontinuity lying in the path of the beam (Figure 2-16).

2) Two search unit reflection technique - this technique is used when the test material is of irregular shape and reflecting surfaces or opposite boundary are not parallel with entrant surface. One search unit becomes the transmitter and the second search unit becomes the receiver. The transmitting search unit projects a beam of vibrations into the material; the vibrations travel through the material and are reflected back to the receiving search unit from any discontinuities or from the opposite boundary if parallel to the entrant surface. (Figure 2-17)

(b) Through Transmission Technique - two search units are used in this method; one acts as transmitter and the second as receiver. The transmitting search unit projects a beam of vibrations into the test material; these vibrations travel through the material to the opposite surface where they are picked up by the receiving search unit (Figure 2-18). Any discontinuities in the path of the beam will cause a reduction in the amount of energy passing through to the receiving search unit.

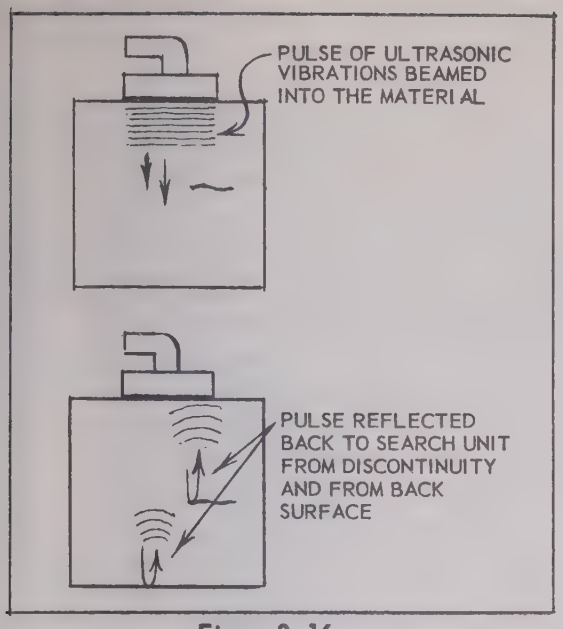

PULSE OF ULTRASONIC VIBRATIONS BEAMED INTO THE MATERIAL
PULSE REFLECTED BACK TO SEARCH UNIT FROM DISCONTINUITY AND FROM BACK SURFACE

Figure 2–16
Single Search Unit Reflection Technique

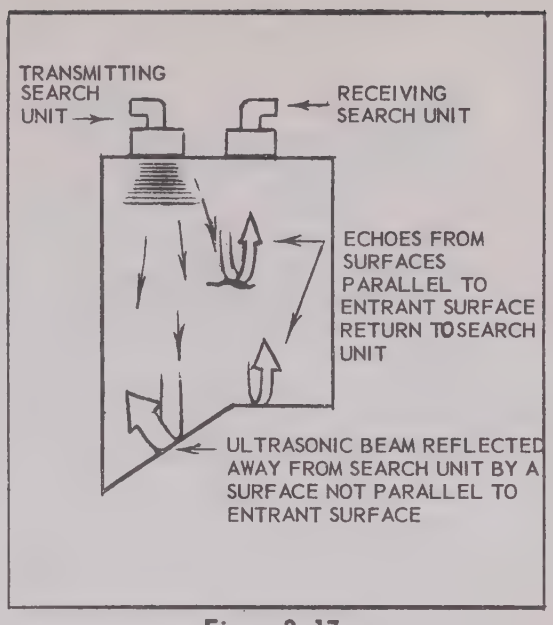

TRANSMITTING SEARCH UNIT
RECEIVING SEARCH UNIT
ECHOES FROM SURFACES PARALLEL TO ENTRANT SURFACE RETURN TO SEARCH UNIT
ULTRASONIC BEAM REFLECTED AWAY FROM SEARCH UNIT BY A SURFACE NOT PARALLEL TO ENTRANT SURFACE

Figure 2–17
Two Search Unit Reflection Technique

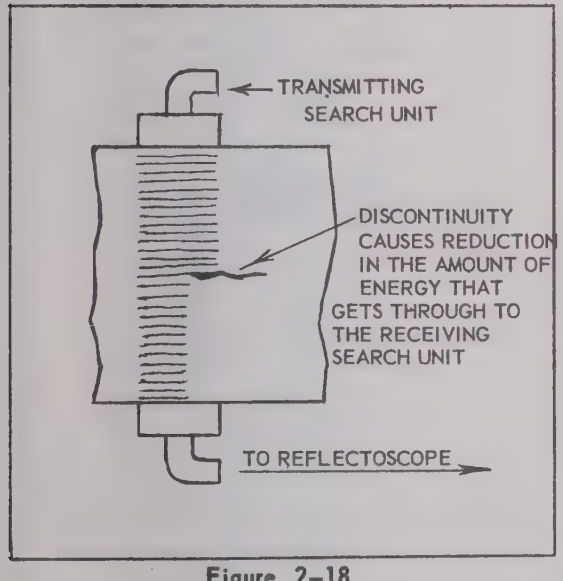

TRANSMITTING SEARCH UNIT
DISCONTINUITY CAUSES REDUCTION IN THE AMOUNT OF ENERGY THAT GETS THROUGH TO THE RECEIVING SEARCH UNIT
TO REFLECTOSCOPE

Figure 2–18

Through Transmission

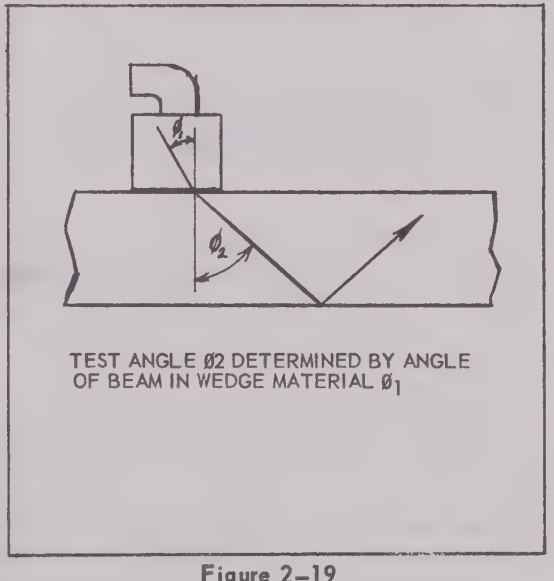


Figure 2–19

Angle Beam Search Unit

(2) Angle Beam Search Units (Contact) - the angle beam search unit is designed so that the beam of vibrations will enter the material under test at an angle to the entrant surface. The crystal is mounted on a plastic wedge so that the ultrasonic waves generated by the crystal will enter the material at a specific angle, depending upon the angle at which it is desired to have the beam travel within the test material (Figure 2-19). In this manner, discontinuities can be located which, due to their orientation, cannot be detected by the straight beam method (Figure 2-20). The angle beam search unit is also used for testing thin material such as sheet and plate (Figure 2-21) and for testing pipe (Figure 2-22).

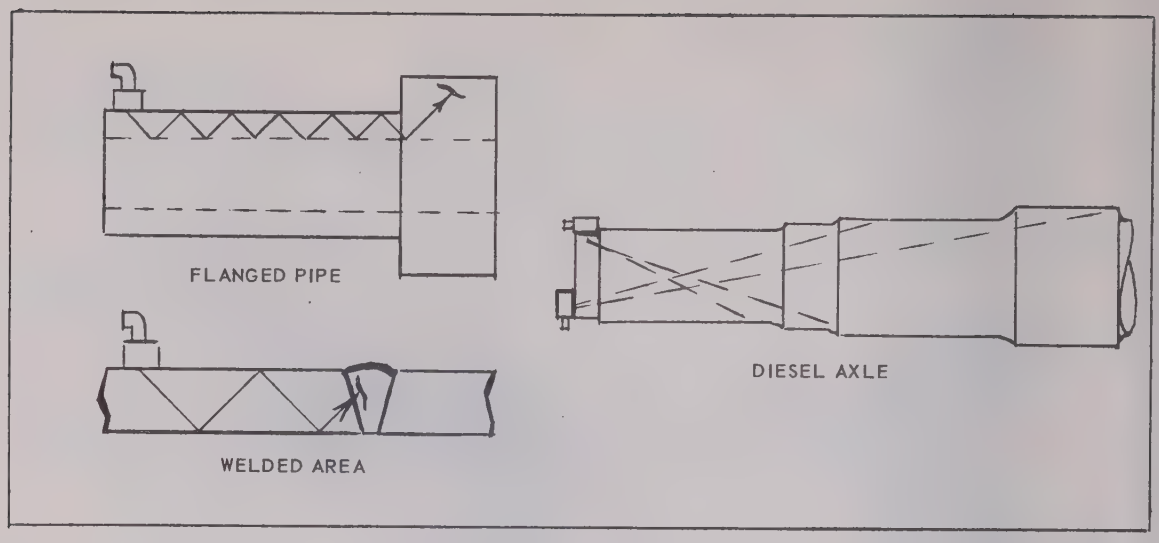


Figure 2–20
Use of Angle Beam to Scan Areas that Straight Beam Cannot Reach

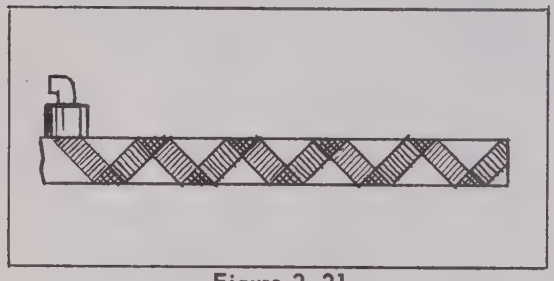


Figure 2–21
Angle Beam Used to Scan Plate and Sheet

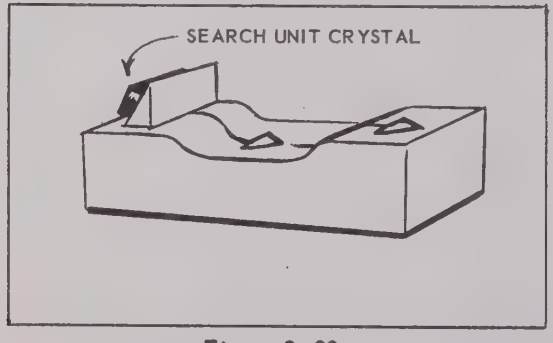


Figure 2–23
Surface Wave Search Unit

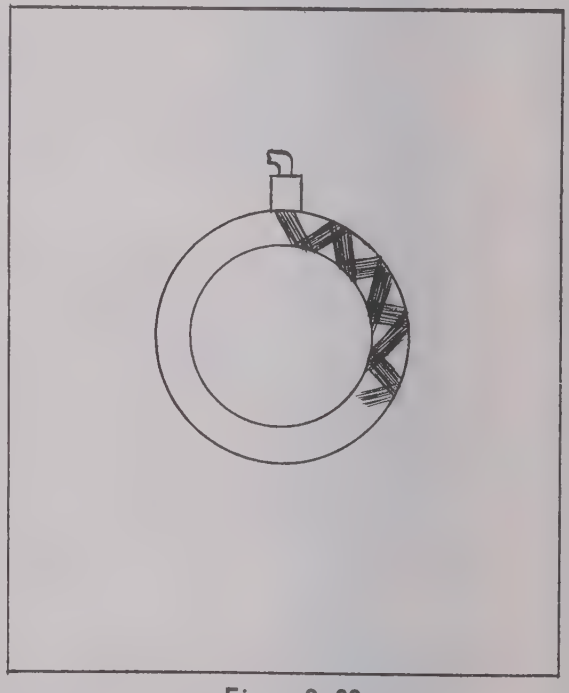


Figure 2–22
Angle Beam Used to Scan Pipe

(3) Surface Wave Search Units - the surface wave search unit is similar to the angle beam in that it uses a wedge to position the crystal at an angle to the test surface. It generates surface waves by refraction (Figure 2-23). The wedge angle $\emptyset_1$ is chosen so that the refracted angle $\emptyset_2$ is 90 degrees.

(4) Lamb Wave Search Units - twin Lamb Wave search units for inspection of thin plate, honeycomb etc. provide simultaneous adjustment of both crystal angles for optimum operation of a two search unit inspection system. (Figures 2-24 and 2-25).

(5) Immersion Search Units - in immersion testing, the search unit and the part to be tested are immersed in water or oil (almost any liquid is suitable for this purpose). The crystal in a waterproof housing can be supported by a simple arrangement for projecting a vertical or horizontal beam (Figure 2-26), or it may be mounted so that it can be rotated in any direction, raised and lowered, or moved back and forth through the tank in order to search over the desired areas (Figure 2-27). To locate discontinuities in the

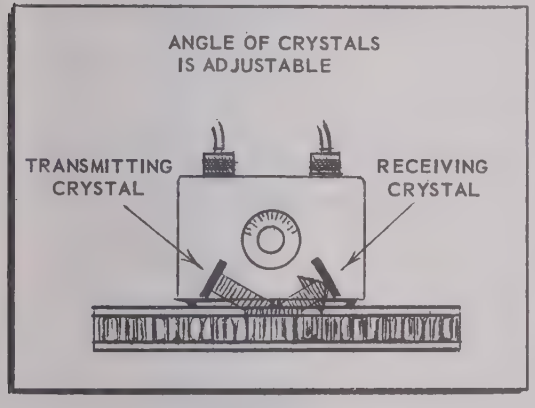


Figure 2-24
Contact Lamb Wave Search Unit

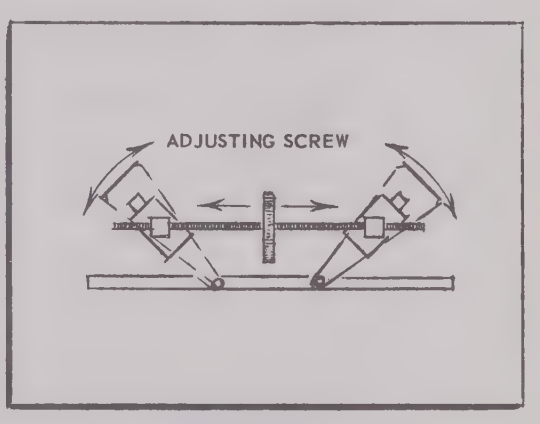


Figure 2-25
Immersion Lamb Wave Search Unit

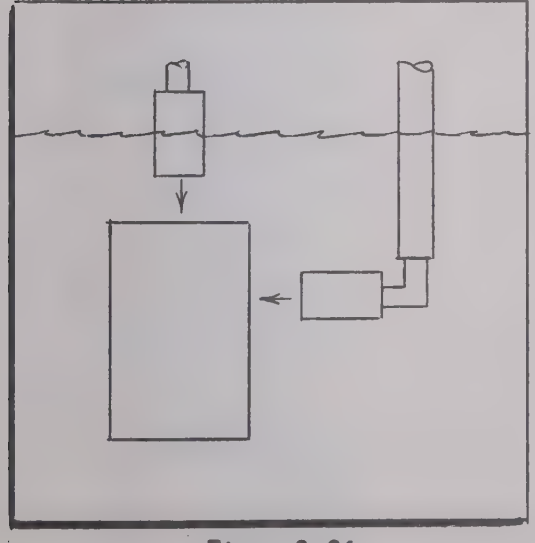


Figure 2-26
Immersion Testing – Simple Arrangements

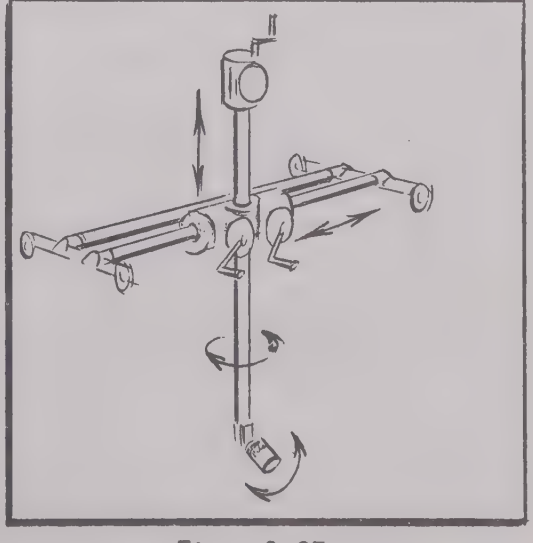


Figure 2-27
Search Unit Positioner

material accurately, it is necessary to know the angle at which the ultrasonic beam enters the material. Using this angle, the angle of refraction in the material and the probable mode of vibration may be calculated (Figure 2-28). Table 2 shows the angle of transmission in three materials when immersed in water.

(6) Liquid Lens - the Liquid Lens adaptor for immersion search units furnishes a means for continuously varying the focus of the ultrasonic sound beam for improved sensitivity in critical or normally difficult test areas.

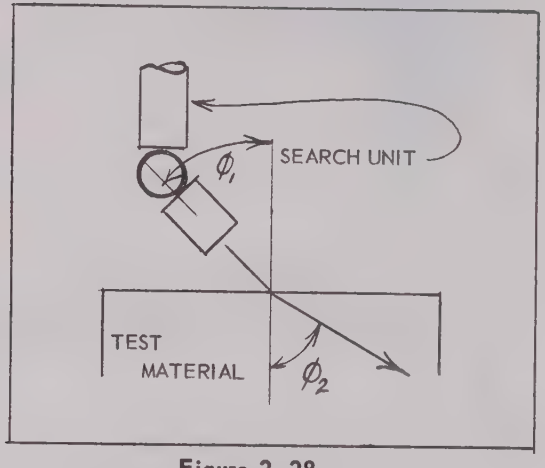


Figure 2–28
Immersion Testing Using
Angle Beam Techniques

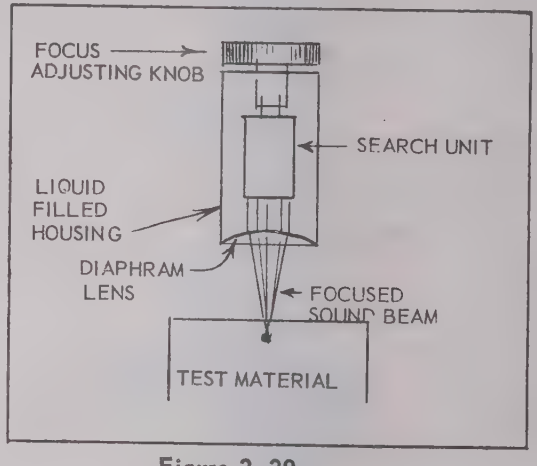


Figure 2–29
Liquid Lens

ϕ_1 WATER	ϕ_2 STEEL		ϕ_2 ALUMINUM		ϕ_2 PHOSPHOR BRONZE	
LONG	LONG	SHEAR	LONG	SHEAR	LONG	SHEAR
1°	3° 58′	2° 7′	4° 14′	2° 3′	2° 29′	1° 30′
10°	43° 20′	21° 35′	47° 21′	20° 53′	24° 10′	15° 3′
12°	55° 44′	26° 0′	62° 52′	25° 16′	29° 22′	18° 5′
15°	Over 90°	33° 14′	Over 90	32° 6′	37° 37′	23° 0′
20°		46° 26′		44° 37′	53° 46′	30° 4′
30°		Over 90°		Over 90	Over 90°	47° 24′
40°						73° 33′
43°						Over 90°

Table 2. Angle of Refraction and Change of Mode of Vibrations in Metals Immersed in Water.

4. VISUAL PRESENTATION

The basic elements involved in producing the display of echoes on the cathode ray tube are as follows:

a. SWEEP (Figure 2-30)

The Sweep of horizontal base line provides a time base for the analysis of all information, interpreted in terms of distance.

b. INDICATIONS (Figure 2-30)

The amplified signals are displayed along the sweep as vertical deflections. The first signal received appears at the left of screen and subsequent ones are spaced toward the right with the distance between them proportional to the elapsed time between their respective times of arrival. The indications are displayed as a Video trace (detected signals appearing as deflections above the sweep line).

c. MARKERS (Figure 2-30)

Square wave markers displayed on a separate horizontal base line, can be expanded or contracted to show desired units of distance.

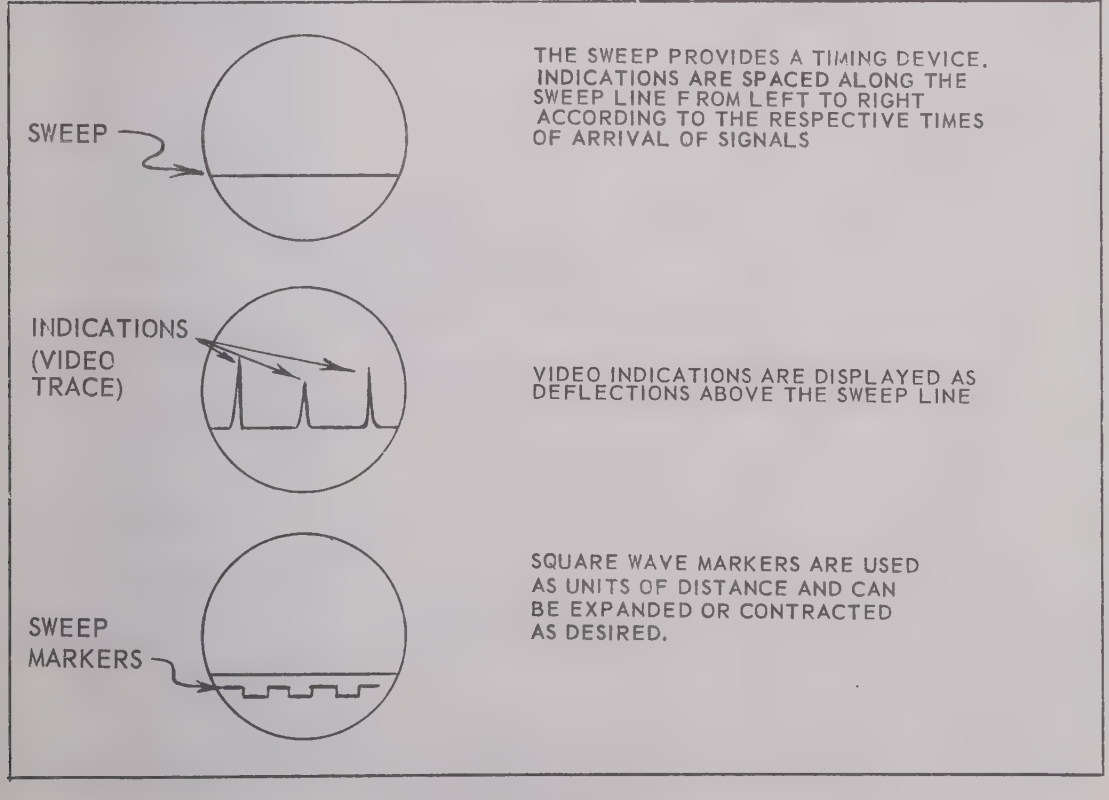

SWEEP
THE SWEEP PROVIDES A TIMING DEVICE. INDICATIONS ARE SPACED ALONG THE SWEEP LINE FROM LEFT TO RIGHT ACCORDING TO THE RESPECTIVE TIMES OF ARRIVAL OF SIGNALS
INDICATIONS (VIDEO TRACE)
VIDEO INDICATIONS ARE DISPLAYED AS DEFLECTIONS ABOVE THE SWEEP LINE
SWEEP MARKERS
SQUARE WAVE MARKERS ARE USED AS UNITS OF DISTANCE AND CAN BE EXPANDED OR CONTRACTED AS DESIRED.

Figure 2-30

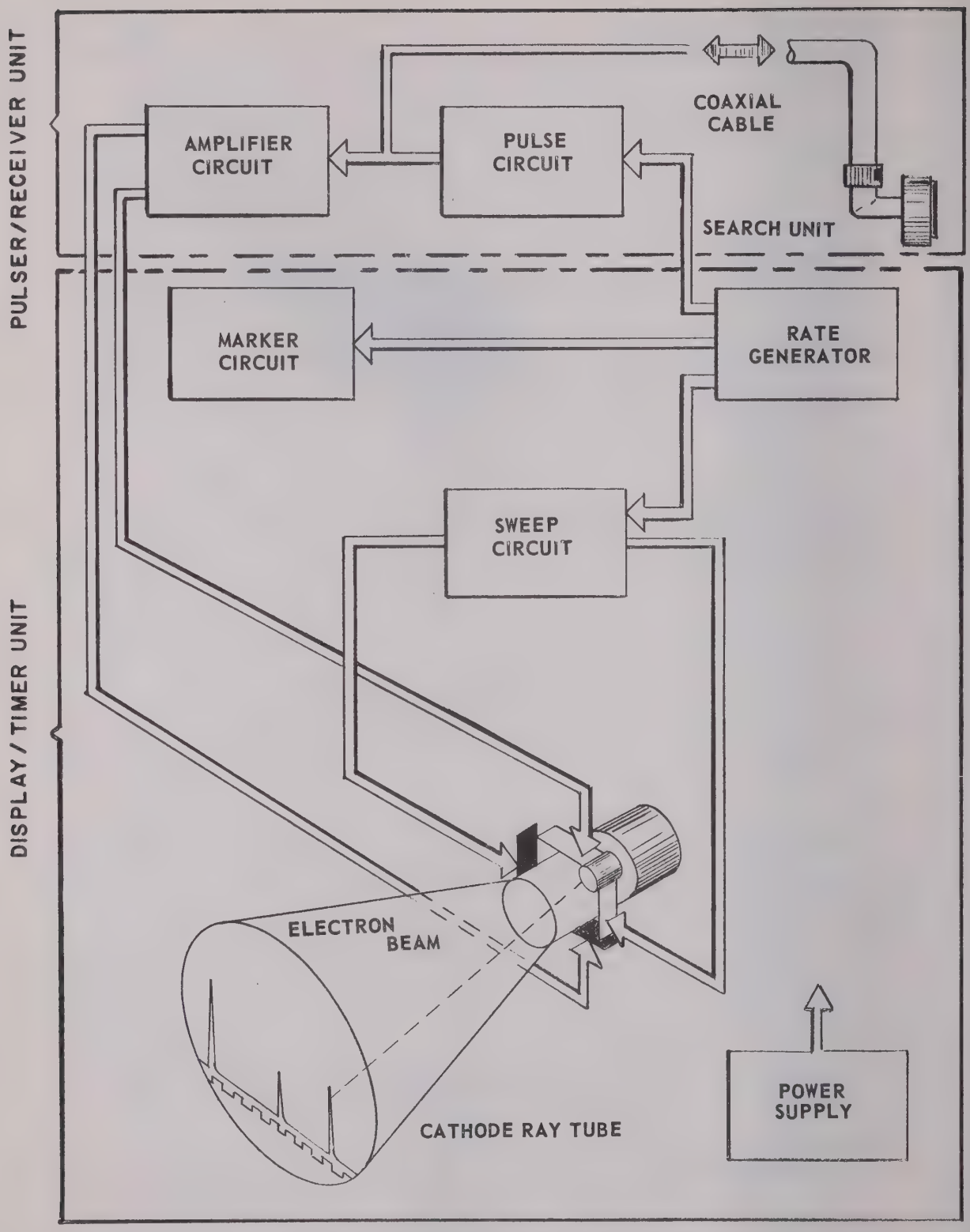


Figure 2-31

Block Diagram Showing UM Component Functions.

5. REFLECTOSCOPE TIMING

Much of the Reflectoscope circuitry is based on time, the time it takes for an electrical signal or electrical pulse to travel a specific distance; the time that something is to start happening and the time something is to stop happening. This time is measured in millionths of a second (microseconds). In plain everyday time measurement, we use a clock or watch to mechanically break down the time information and present it so that it can easily be understood. The hands moving around the face of the clock present a visual picture of time which can be interpreted at a glance. In the operation of the Reflectoscope, the cathode ray tube screen can be compared to the face of the clock, the horizontal sweep line can be compared to the line along which the points of the clock's hands move, and the pips appearing along the sweep, represent segments of time and can be translated into segments of distance.

Before we can translate time into distance, we must establish a point from which to start all time measurements. The fixed point from which time is to be measured in the operation of the instrument must be visible to the operator; therefore, we use the first visible fixed indication, the Initial Pulse, as this starting point.

The Initial Pulse is the pulse of electrical vibrations which has arrived at the search unit from which it is to be projected into the material in the form of sound. This signal is fed to the echo pulse amplifier, as well as the search unit, and thus may be displayed on the cathode ray tube screen as the fixed point from which to start timing. In order to illustrate time as seen on the Reflectoscope cathode ray tube screen, we may draw a horizontal line and call it the Time Base or Sweep. Time starts at the left end of the Time Base and progresses to the right. (Figure 2-32).

The horizontal line appearing on the cathode ray tube screen is the Sweep. The Sweep is a visual presentation of a portion of the Time Base. The position and the duration of this portion or period of time can be varied so that we can select the segment of time we wish to "see." We can select the point along the Time Base which is to be the start of the visual time and we can select the point at which it is to end or, in other words, its duration. A mark is placed on the Time Base at the Initial Pulse to indicate the start of the Sweep and a mark after the Initial Pulse to indicate the end or duration of the Sweep, and we indicate that both start and duration are variable. (Figure 2-32).

The visual display of time on the cathode ray screen can be translated into inches of material. Since the speed of sound is different in different materials this must be taken into account. Display/Timer con-

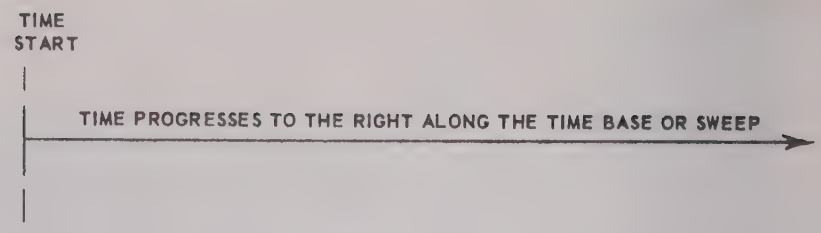


Figure 2-32

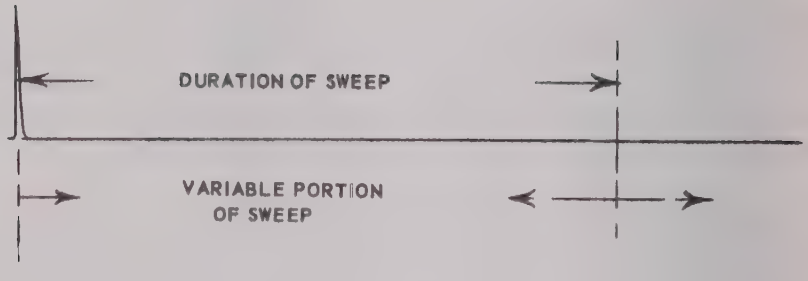


Figure 2-33

trols allow display of most materials, calibrated directly in inches. In addition, any portion of the test period may be displayed. The sweep can be started from 2 inches prior to initial pulse to 4 feet after initial pulse, and the duration of the sweep period is variable from 1 inch to 40 feet. This can be illustrated as follows:

a. SWEEP DELAY

Let us imagine that the outline of the cathode ray tube screen or the bezel is a picture frame and that we can move the picture frame back and forth horizontally over a large picture. As we move the frame from left to right, the picture appears to be going by with objects appearing at the right and disappearing off to the left as though we were looking through the window of a slow moving train. If we apply this to the cathode ray tube display, the pips appear to move from one side to the other along the sweep. Actually, the pips are stationary along the Time Base; the only thing that moves is the frame of the picture. What we see is a portion of the Time Base, with the start of the portion at the left edge of the picture and the end of the portion or period of time at the right edge of the picture. (Figure 2-34).

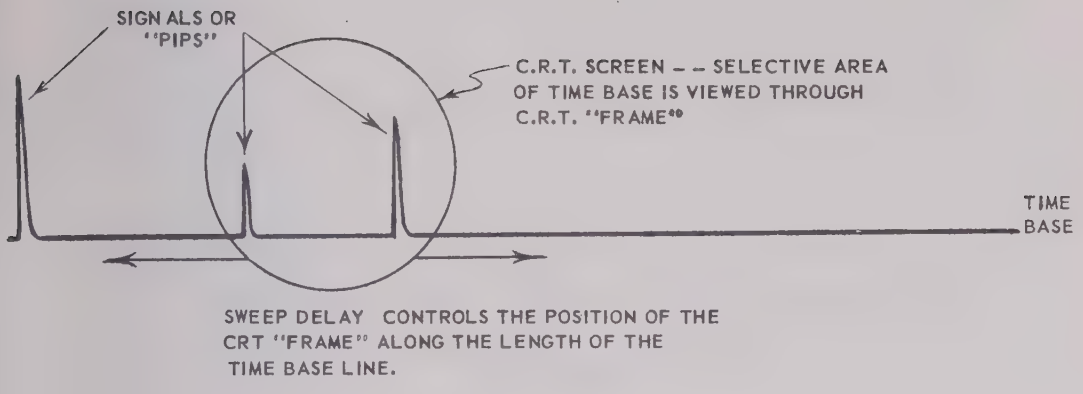


Figure 2-34

Figure 2-35 shows that when using the Sweep Delay control, the picture of a test can be started at any point from 2'' before to 4' after the Initial Pulse.

b. SWEEP LENGTH

To illustrate the Sweep Length control, we use the frame again to represent the outline of the CRT screen and compare the Sweep to a strip of rubber. The strip of rubber is marked at a number of points along its length (to represent points in time) and one end of the strip is attached to the left side of the picture frame (Figure 2-36). With the rubber strip attached as show in Figure 2-36, we see a number of marks in the framed length of rubber. If we pull on the end of the rubber strip and stretch it to the right, we will see fewer of the strip's marks through the frame. If we compare this to the cathode ray tube display, we see a smaller portion of the Time Base when we stretch or expand the sweep, and a larger portion of time when we compress the Sweep.

The rubber strip remains fixed at the left side of the frame because we have attached it there; therefore, only the rubber strip to the right of the attached point will stretch or move. The same applies to the Sweep. The point in time that we wish to start our picture becomes fixed and only the time after that is expandable or compressible.

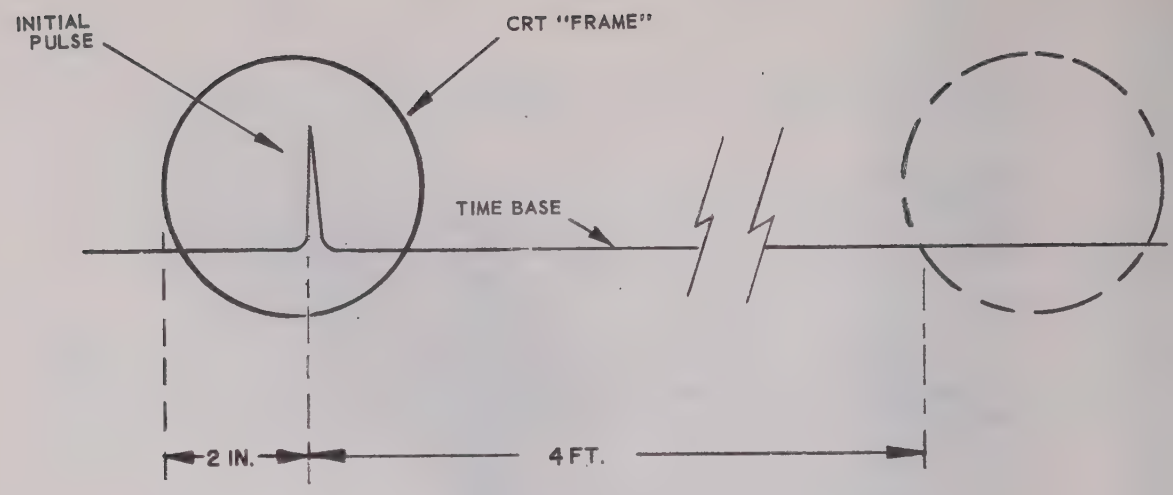


Figure 2–35

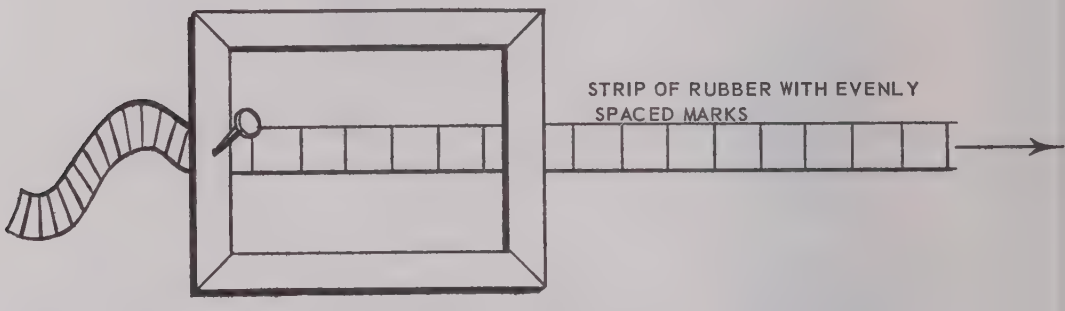


Figure 2–36

To translate this into usable information we say that the duration of the Sweep in the Reflectoscope is variable from 1 inch to 40 feet. In other words, the full width of the display can be made to represent as little as 1 inch of material or as much as 40 feet of material. (Figure 2-37)

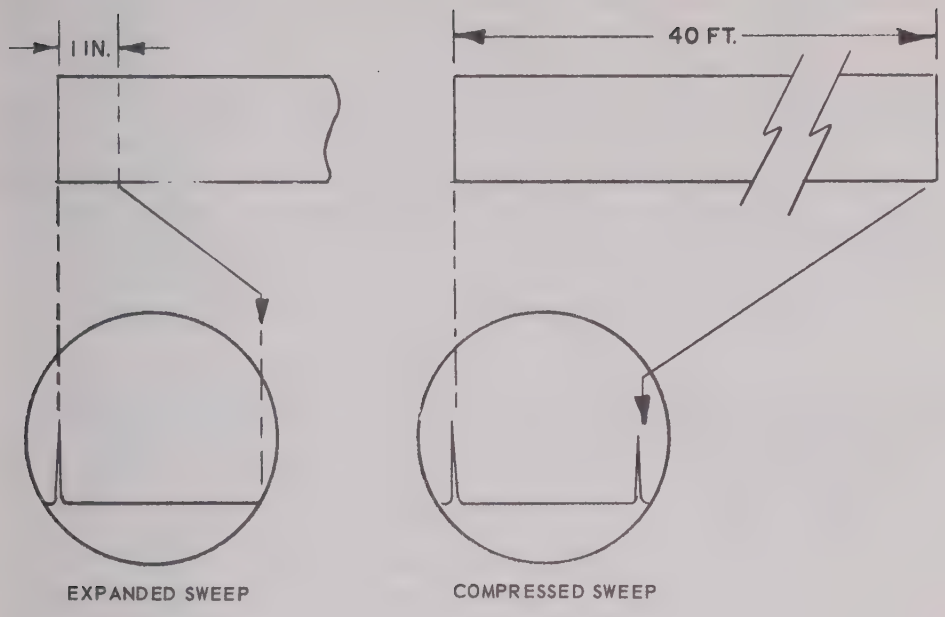


Figure 2 –37

Two examples of the use of time have been described above. The first is the timing of the start of the Sweep; we can start our picture anywhere along the Time Base up to certain limits. The second example shows how the Sweep, or visible portion of the Time Base, can be expanded so that only a small portion of time shows on CRT display or compressed so that a large portion of time shows on CRT display.

c. INTERFACE SYNC

In the Reflectoscope, the start of the Sweep can be delayed by two methods, Manual Sweep Delay described above and Automatic Sweep Delay in instruments which provide interface sync.

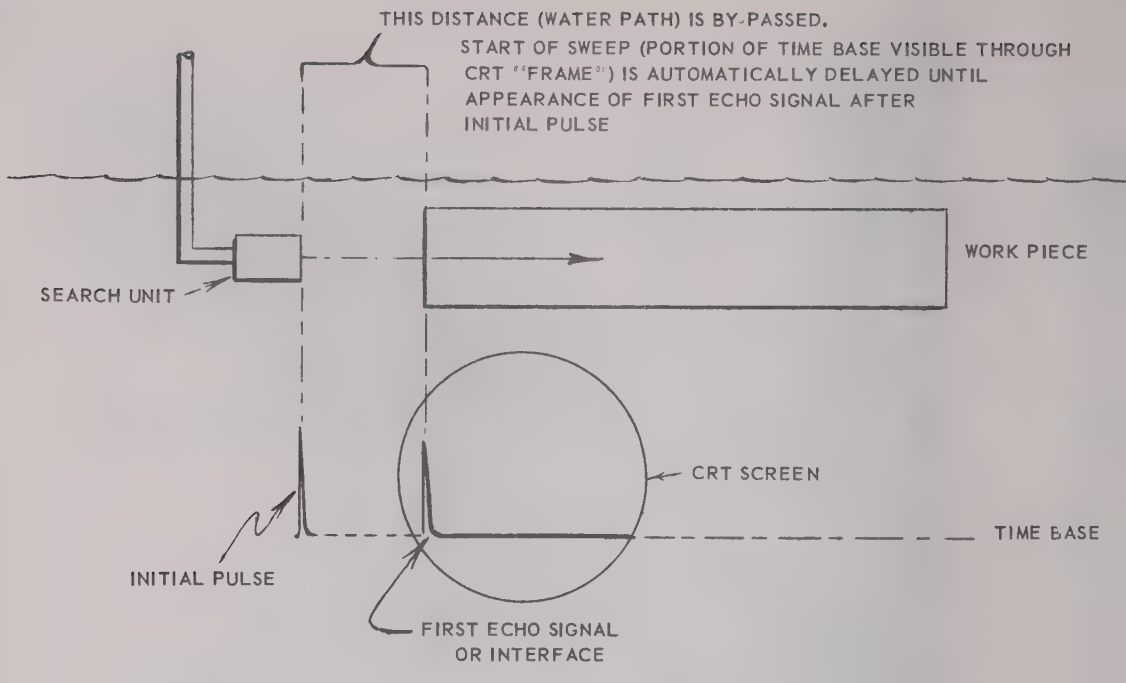

THIS DISTANCE (WATER PATH) IS BY-PASSED.
START OF SWEEP (PORTION OF TIME BASE VISIBLE THROUGH CRT "FRAME") IS AUTOMATICALLY DELAYED UNTIL APPEARANCE OF FIRST ECHO SIGNAL AFTER INITIAL PULSE
WORK PIECE
SEARCH UNIT
CRT SCREEN
TIME BASE
INITIAL PULSE
FIRST ECHO SIGNAL OR INTERFACE

Figure 2–38

Interface Sync is used for immersion inspection when it is desired to start the sweep at the interface echo signal. This is accomplished automatically by delaying the start of the Sweep until the first echo signal occurs. In immersion testing, the first echo signal to come along after the Initial Pulse is the reflection from the entering surface of the workpiece, or interface signal. (Figure 2-38). The start of the sweep is synchronized with this First Echo Signal and remains "locked in" regardless of changes in distance which may occur between the search unit and the surface of the workpiece. (Figure 2-39). A Transigate unit is necessary for interface sync operation.

d. TRANSIGATE SYSTEM

In the Transigate, gates or intervals are used to establish inspection zones within which signals of predetermined amplitudes will activate the alarm or recording system. These gates are time sensitive periods and are predetermined segments of the Time Base. The start of each gate and its duration are independently controlled. These gates appear on the cathode ray tube display as inverted pedestal markers on the Sweep line. Up to four gates can be used simultaneously. (Figure 2-40).

e. MEASUREMENT OF DISTANCE IN MATERIALS

What we see on the cathode ray tube screen is a display of time. The sweep represents the visible portion or period of the Time Base. The indications or pips represent signals returned to the instrument from various points along the Time Base. These pips are arranged along the Sweep from left to right according to their various times of arrival. The distance from the Initial Pulse to each pip displayed along the Sweep is directly proportional to the time required for the projected energy to travel from the search unit. This information can be converted to distance in inches, feet, etc. by direct readings on the CRT screen or by use of the markers as described in Section III.

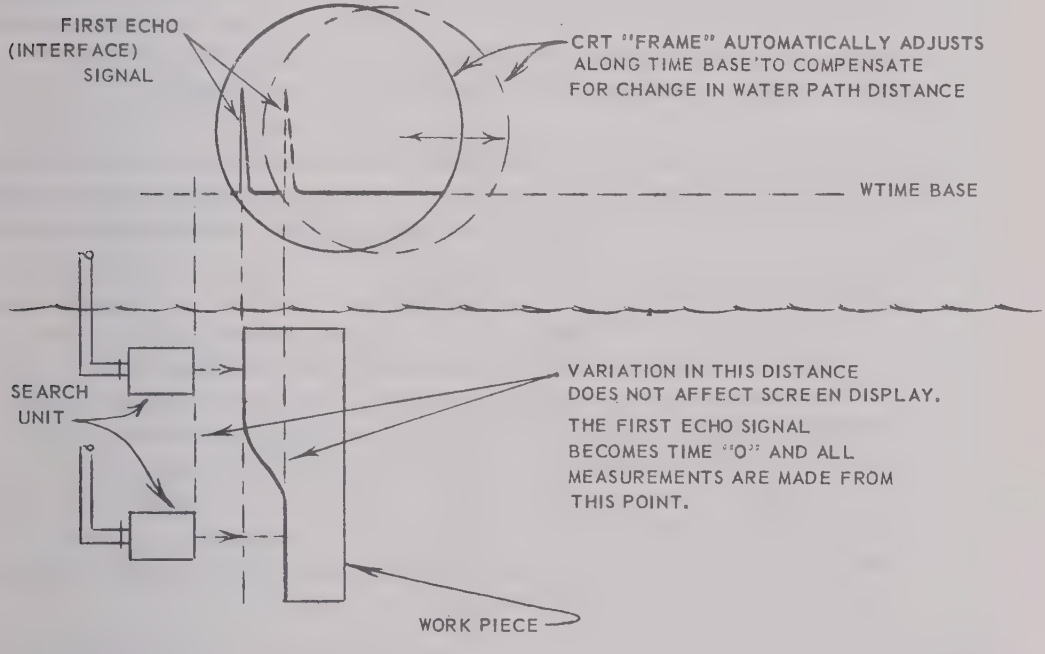


Figure 2-39

Figure 2-40

f. PULSE REPETITION RATE

The generation of the ultrasonic pulse and its propagation into the material is entirely a Reflectoscope function. The generation of the ultrasonic pulse is accomplished by producing a radio frequency pulse of desired frequency at a precise time, then converting the pulse into ultrasonic vibrations by means of a piezoelectric crystal. The crystal is actuated for a controllable period of time (as little as a millionth of a second), resulting in a short burst of sound waves. This pulse travels through the material to the opposite boundary where it is reflected back to the source as an echo. The returned energy is transformed by the crystal into electrical vibrations and displayed on the CRT as a vertical pip. This cycle of transmitting and receiving pulses is repeated at a rate (Repetition Rate) that varies from 50 to 1000 pulses per second (pps).

The UM 715 and 721 automatically adjust pulse rate for maximum brilliance of display and complete compatibility with the test being made. When the sweep length has a short duration, pulse rate is high (factory set for 1000 pps). Since a short time is needed for the sweep, many more pulses per second can be transmitted. The high pulse rate is needed to keep the trace bright as it would otherwise dim out at the fast sweep speeds. When the sweep length is long the pulse rate is automatically lowered (factory set for 100 pps). This is necessary to allow enough time for the entire sweep to be displayed before another transmitted pulse is initiated. Figure 2-41 shows the time relationship. For any combination of front panel controls there will always be a short recovery time between the end of the sweep and the start of the next test period.

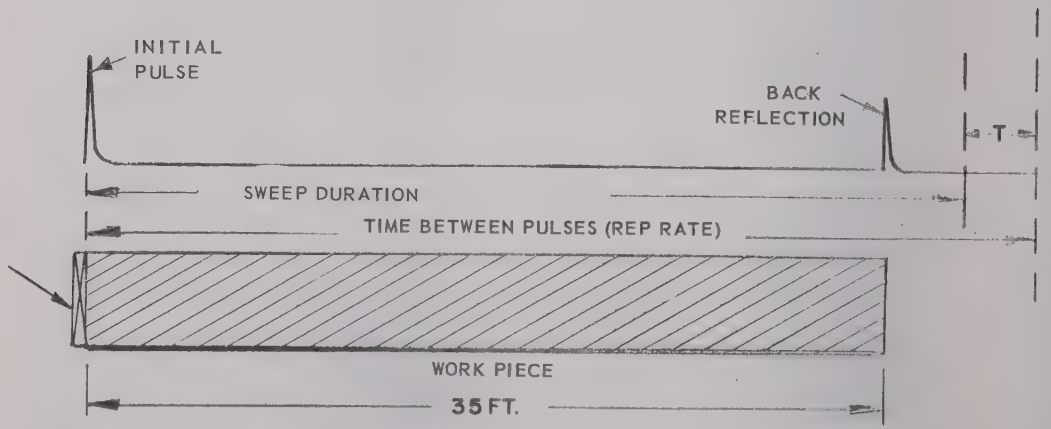


Figure 2-41

SECTION III

FAMILIARIZATION

BASIC TRAINING PROCEDURE

The purpose of this section is to provide the new operator with a knowledge of the basic operating procedures and testing techniques employed in ultrasonic testing with a Sperry Reflectoscope. This section is not intended to be a complete instruction on Reflectoscope operation - its purpose is merely one of familiarization and training.

Testing with the UM Reflectoscope is both rapid and simple. However, it does demand, on the part of the operator, a complete familiarity with the instrument, with testing techniques and with the physical characteristics of the material being tested.

The new operator should follow the instructions given in this section the first time he uses the instrument. It is recommended that the procedures be run through several times thereafter, and that the operator experiment with various combinations to further familiarize himself with the operating characteristics of the instrument.

NOTE

While specific procedures may vary in detail, depending on the particular selection of plug-in components, the instructions in this Section are designed to provide basic training for general UM Reflectoscope testing.

1. SETUP PROCEDURE

a. PREPARATION FOR USE

(1) Assemble the following accessory equipment:

(a) Waste cloths and oil can with SAE 20 or 30 oil.

(b) Test block Sperry Style 50A099.

(2) Place Reflectoscope on work bench or other suitable location.

(3) Check to assure that the Pulser/Receiver unit is securely plugged in and knurled locking knobs are turned finger tight.

(4) Connect end of power cord to power plug at rear of cabinet.

(5) Connect other end of power cord to power supply. (See nameplate).

NOTE

Make certain that the instrument is grounded. A grounding wire is provided in the 3-wire power cord but in some locations, additional grounding may be necessary. Grounding magnet and cable Style 50A110 may be used to assure ground.

2. FAMILIARIZATION

The following procedures are outlined to give preliminary familiarization with UM Reflectoscope Component controls:

a. DISPLAY/TIMER UNIT

(1) Set display controls at the following approximate positions:

(a) Scale Illumination and Power Switch - turn clockwise and adjust for desired scale intensity.

(b) Intensity - adjust for minimum visible spot with no bright spot at beginning of left end of trace.

CAUTION

If intensity is allowed at a high level of brightness for long periods, it is possible to permanently burn a line or spot on the CRT tube. No bright "dot" should be allowed to appear at the ends of the trace at any time.

(c) Astigmatism and Focus - adjust for sharpest trace on both vertical and horizontal lines.

(d) Horizontal Positioning - set to place sweep start at left edge of the screen.

(e) Vertical Positioning - adjust so that trace line appears on zero scribe line on bezel.

(2) Sweep - set toggle switch to "dial" position, set dial to aluminum, and lever switch to 1 x .1 (both in up position).

(3) Sweep Delay - set switch to position 1 and adjust knob so leading edge of initial pulse coincides with first vertical index mark at left of CRT screen. Use vernier control for fine adjustment.

(4) Markers - set marker switch to "OFF" position.

b. PULSER/RECEIVER UNIT

(1) Reject - minimum position (full counterclockwise).

(2) Pulse Length - quarter turn from full counterclockwise.

(3) Connect one end of search cable to threaded connector marked R on front panel of Pulser/Receiver unit.

(4) Connect other end of cable to 5.0 mc straight beam search unit.

CAUTION

Turn the knurled connector rings on each end of search cable finger tight only.

(5) Test Switch - set to normal.

(6) Frequency - set to frequency of search unit.

(7) Sensitivity - approximately 1 on the dial and x1 on the slide switch

c. TESTING

Using Test Block (50A099), place a few drops of oil on long edge surface with large test hole away from oiled surface. Place search unit on oiled surface and note indications appearing on scope. It may be necessary to change sensitivity so that indications are of useful height. Moving the search unit back and forth along the oiled surface, locate test holes on the scope, then by changing each of the controls, become familiar with the result of such adjustments. (Figure 3-1).

NOTE

All voltages are internally regulated to provide stable operation within voltage range from 105 - 125 volts. Should additional regulation be required, a Sola Constant Voltage Transformer, Sperry No. 50C383 (Sola 23-22-150) should be used.

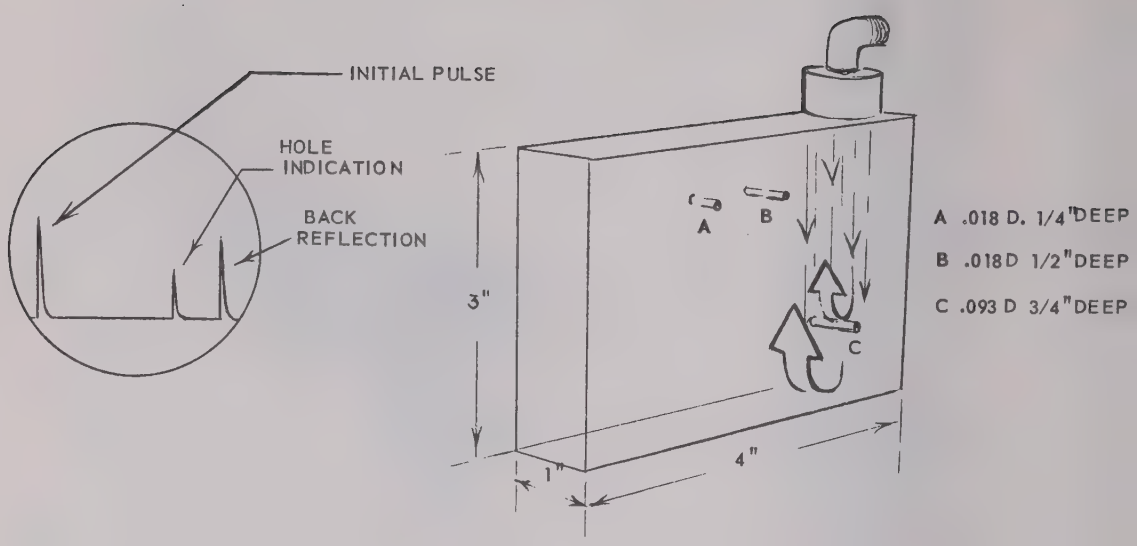


Figure 3-1

3. FAMILIARIZATION - DETAIL

With search unit over large hole as in Figure 3-1, use the Sensitivity control to vary the amplitude of indications and set control so that the back reflection appears approximately 3" high.

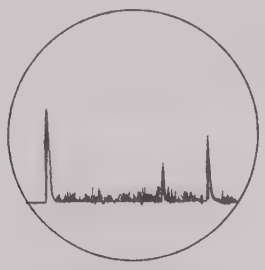
a. PULSER/RECEIVER

(1) Study the action of the Pulse Length control. Longer pulse for penetration, shorter pulse for resolution. Set Pulse Length control full ccw for shortest pulse.

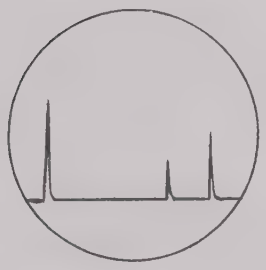
(2) Study the action of the Reject control. Note that the indications are shortened as more reject is applied by turning control clockwise. Although the indications appear to be shortened as with Sensitivity control, note that the smallest indications disappear completely when enough reject is applied. Sensitivity reduces or increases the amplitude of all indications proportionately whereas reject is used to "clip" off the bottoms of indications to remove undesirable small signals. (Figure 3-2). Return Reject to OFF, full ccw and it should remain OFF during familiarization operations.

CAUTION

The Reject Control should be used with discretion. The operator should always bear in mind that even small indications may be important when interpreting test patterns of the CRT display. Use of reject destroys linearity of signal amplitude relationship, thereby making evaluation of defect size difficult or impossible.



WITHOUT REJECT



WITH REJECT – SMALL BASE LINE SIGNALS HAVE BEEN CLIPPED OFF PRESENTING A CLEANER BASE LINE

Figure 3–2

b. DISPLAY/TIMER UNIT

(1) Place search unit on block so that only the Back Reflection shows. Move lever switches downward and note that the Back Reflection moves to the left toward the Initial Pulse and that more indications appear moving in from the right side of screen. (Figure 3-3). Sound bounces off the bottom of the block and travels to the top of the block where a portion is transformed into electrical energy by the crystal, is amplified and displayed on the screen as the first Back Reflection. Some of the sound bounces back down to the bottom of the block and then again to the top and appears on the screen as the second Back Reflection. This

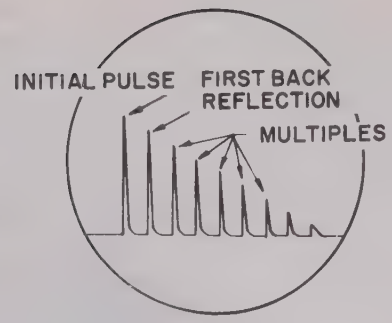


Figure 3-3

bouncing between top and bottom surfaces is repeated until the sound is completely attenuated. All these bounces appear on the screen as multiples of the first back Reflection and are equally spaced on the trace. In other words, if the distance between top and bottom surfaces of the block is 3", then ten multiples of the Back Reflection will represent 30". The Sweep controls allow us to see more time, more material or deeper into the material.

(2) Lift the search unit from block and turn Marker switch to position 1. Square wave markers will appear on the alternate trace.

(3) Turn Marker Fine and Vernier controls clockwise and note that the markers stretch out. They become compressed when controls are turned counterclockwise.

(4) With a small screw driver adjust the alternate display shift vertical control to position the alternate trace as desired. Normally it is spaced just below the main display.

(5) With a small screw driver adjust the alternate display shift horizontal control. Set the start of the first marker to coincide with the start of the initial pulse.

(6) Return search unit to a position on reference block at which only the back Reflection shows. Set Sweep to 5 x .1 position. Adjust Marker controls until three full square waves (Figure 3-4) appear between the leading edge of the Initial Pulse and the leading edge of the Back Reflection (Figure 3-5). Note that each half square wave coincides with the vertical index marks on the CRT, since the sweep is set for .5"/div. Correct any error with material dial.

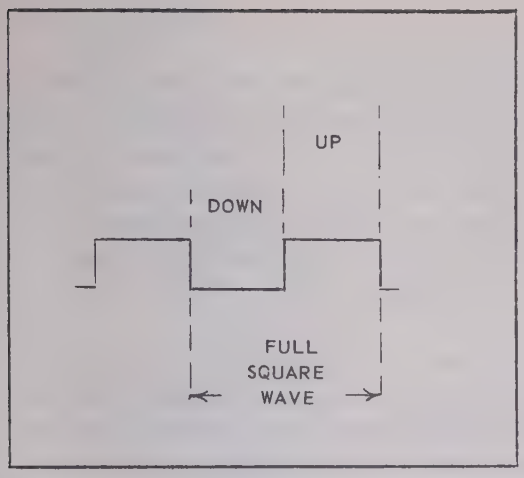


Figure 3–4

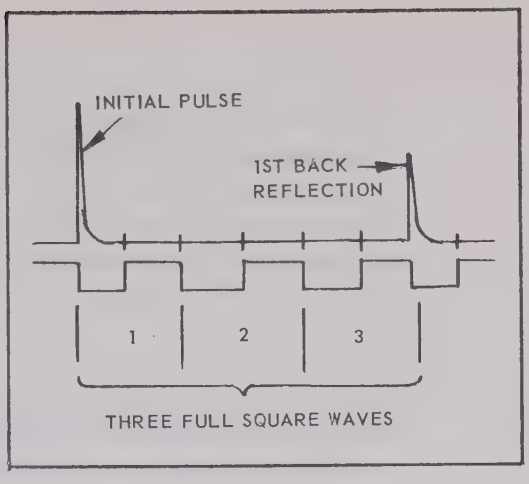


Figure 3–5

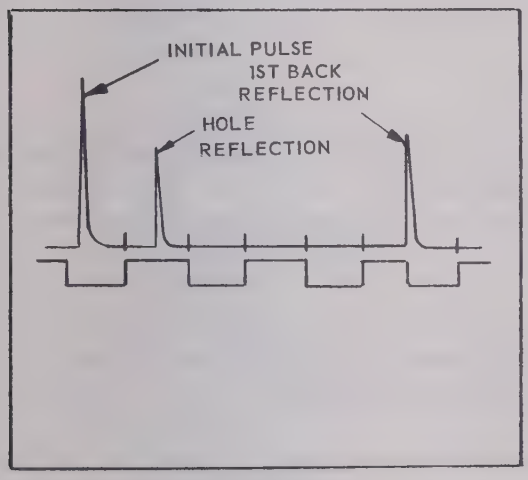


Figure 3–6

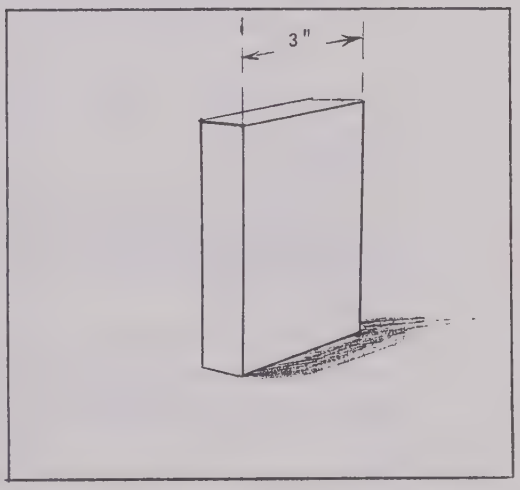


Figure 3–7

(7) Move search unit over large hole and check number of square waves to hole indication.

(8) Slide search unit to the left along top of block until the reflection from the middle hole appears on CRT. Check markers and note that the hole is 3/4" from the top surface. (Figure 3-6). Check with CRT wave calibration.

(9) Repeat above steps with search unit over other small hole.

(10) Turn block so that it rests on its three-inch surface (Figure 3-7). Place search unit on top surface so that only Back Reflection appears.

(11) Set Sweep to 2 x 1. Note that both Indication Display and Marker trace contract and appear to move to the left. Position three back reflections on CRT. Count full square waves between Back Reflections - there should be twelve square waves to the third Back Reflection. Check with scale calibration. This is set for 2 inches/div. Third reflection should occur at 6 divisions.

(12) Try several other measurement combinations - 2 or more square waves to the inch for more accurate short shots and one or two square waves to the foot for long shots. Check each measurement with the scale calibration.

(13) Review preceding steps until a thorough understanding of the use of a reference block, square waves, and scale calibration for measuring distance is attained.

(14) Turn Marker switch OFF.

(15) With search unit on 3" surface of block, move lever switches down and note that more indications appear on CRT. We are "seeing" more time, in other words the visible sweep represents a greater distance.

(16) Move lever switches up and note that the indications move off screen to the right until only one Back Reflection is left. We now "see" less time or shorter distance.

(17) Place search unit on 3" surface of reference block to obtain Back Reflection.

(18) Rotate Sweep Delay controls clockwise and note that the first Back Reflection moves toward the left side of screen. We are now seeing a segment of time further away beyond the position of the back Reflection. (Figure 3-8).

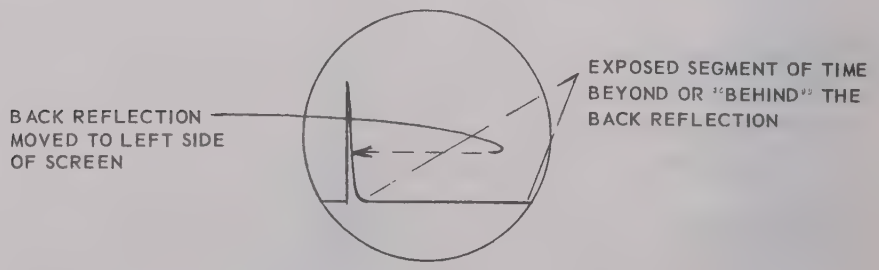


Figure 3-8

NOTE

It is important to become completely familiar with Sweep Delay and Sweep Length in order to understand what we see on the screen and to know what part of the test piece they represent. Sweep Delay permits you to "see" a portion of the material at a distance from the test surface. Sweep Length allows you to see more or less material.

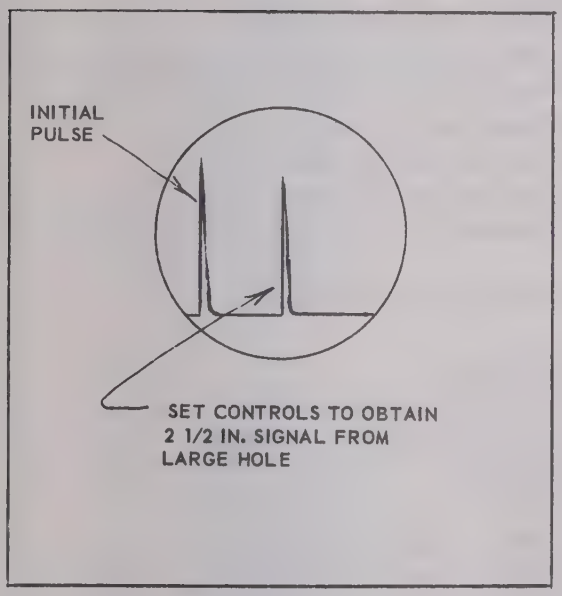


Figure 3-9

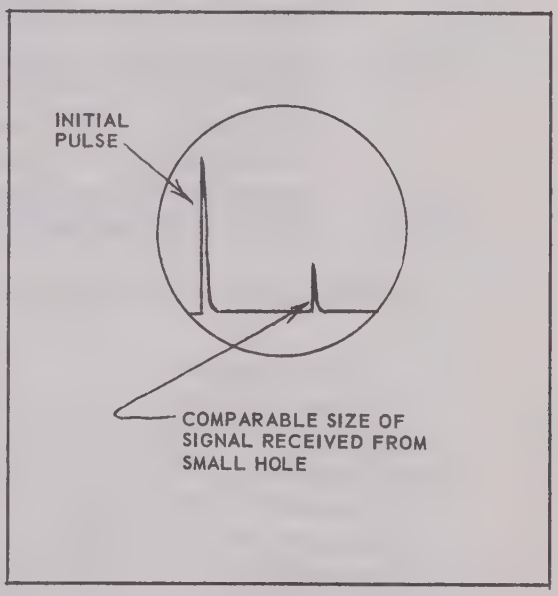


Figure 3-10

(19) Set Sweep to 5 x .1 and set Sweep Delay so initial pulse starts at first calibration mark.

(20) With search unit over the large hole, set controls to obtain a 2 1/2" hole indication. (Figure 3-9).

(21) Move search unit over small hole and note the difference in size of hole indications. (Figure 3-10).

4. ANGLE BEAM TESTING TECHNIQUE (CONTACT)

The procedure for familiarization with the angle beam technique is similar to that used for the straight beam technique. The angle beam search unit is designed so that the sound beam enters the material

under test at an angle to the surface on which the search unit is applied. The following procedure should be used by a new operator in order to familiarize himself with the angle beam testing technique:

a. Set up the Reflectoscope for use. Allow warm-up period of five minutes.

b. Select a 2.25 mc type SW or ST 45° angle beam search unit and attach to the search cable.

NOTE

When the angle beam SU is attached, the initial pulse broadens and small signals appear close to the initial pulse. This is a result of reverberations within the search unit. It is normal and these signals should not be confused with signals from defects or the back reflection.

c. Position controls of the Reflectoscope as follows:

(1) Pulse Length	- 1/4 Turn cw.
(2) Pulse Tuning	- Adjust as required
(3) Sweep	- 2 x 10 (Adjust as required)
(4) Frequency	- 2.25 mc
(5) Sensitivity Multiplier	- x .1
(6) Sensitivity	- 2 (Adjust as required)
(7) Markers	- OFF
(8) Reject	- OFF
(9) Test	- Normal

d. Place the standard test block so that the large hole faces you and is at the lower right.

e. Place a few drops of SAE 30 engine oil on the top surface of the block.

f. Place the 45° search unit on the block as shown in Figure 3-11. For most satisfactory results, the SU should be worked back and forth and, at the same time, twisted slightly side to side in a rotary motion so as to cover an arc of 20 to 30 degrees. This assures complete coverage of the material under test. (Figures 3-11 and 3-12).

g. Move the search unit slowly to the left end of the block until a picture similar to that in Figure 3-12 appears.

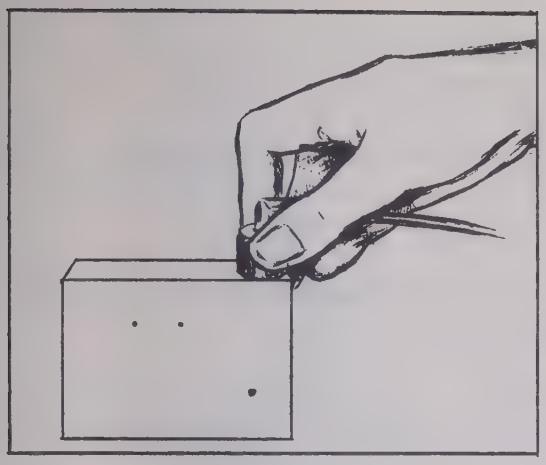


Figure 3–11

Angle Beam Search Unit Placed On Standard Test Block

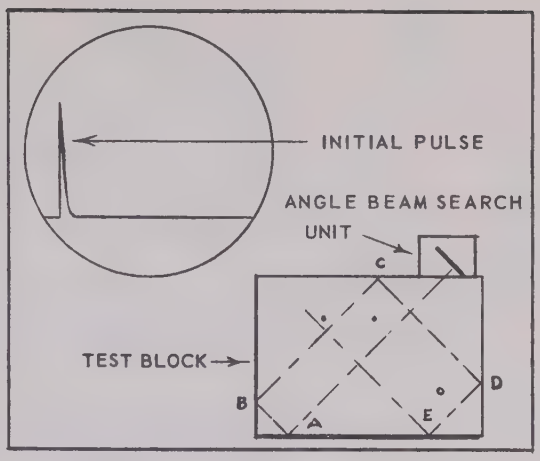


Figure 3–12

Path of Angle Sound Beam Through The Test Block. No Reflection From Holes – Note, Step 7.

NOTE

The path of a beam at this time is shown in Figure 3-12. It will be seen that the beam is progressing from surface to surface inside the block from A to B etc. and that it fails to strike any defect surfaces which are in a position to reflect the sound beam back to the search unit. Eventually some of the sound beam may return to the search unit surface. However, because of attenuation or weakening of the beam as it travels through the material, the beam may be dissipated before the return path is completed. As mentioned in the preceding note, the operator will observe that several small indications appear along the base line when the SU is attached to the cable. These are due to reflections from within the search unit. Not all the sound energy passes through the plastic wedge of the search unit to the test surface. Some of it reflects around inside the wedge until it strikes the crystal, causing what appears to be a wide initial pulse even at a minimum Pulse Length setting. Additional small reflections appear when the Search unit is applied to the test block. These reflections are from the side of the test block and are due to the fact that the beam does not travel per-

fectly parallel, but fans out somewhat from the crystal face. The small return signal halfway out on the base line is a result of a portion of the beam reflecting from around point D directly back to the SU. This action becomes more understandable upon proceeding to the next step.

h. Slide the search unit slowly toward the left until a pattern similar to that shown in Figure 3-13 is attained.

NOTE

By checking back to the diagram of the sound path in Figure 3-12, the presence of the large reflection is easily understood. Careful observation of the screen may reveal a small reflection near the initial pulse. This can be explained by the fact that the .018 inch diameter by 1/2" deep hole in the middle of the block is being intercepted by the divergent sound beam.

i. Move the search unit further to the left. This will bring about a growth of the middle hole reflections and a reduction of the return from the opposite corner of the block. (See Figure 3-14).

j. Continue moving the search unit along the block until patterns similar to those shown in Figures 3-15, 3-16 and 3-17 are obtained.

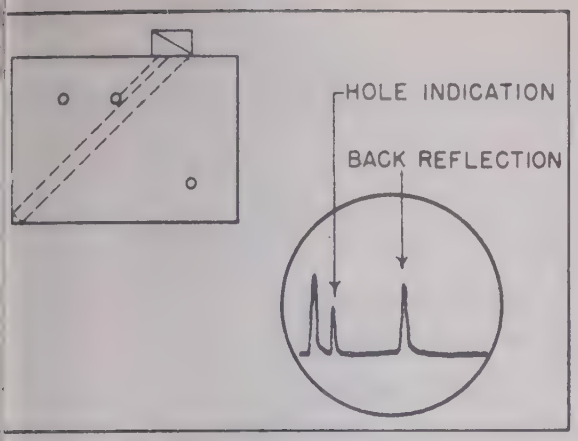
k. Repeat the foregoing procedure until complete familiarity with the angle beam search technique is attained.

5. THROUGH- TRANSMISSION (Two-crystal operation - contact)

a. Assemble the following items in addition to those required for single search unit operation:

(1) Standard 6' 4" cable.
(2) Two 4' 8" cables.
(3) Two straight beam search units of the same frequency (2.25 mc for this test).
(4) Aluminum block with saw cut notch. (See Figure 3-18).

b. Connect one end of a 6' 4" cable to the receptacle marked "R" and to the other and connect a 2.25 mc search unit. This becomes the Receiving search unit.



gure 3–13 Beam reflected from middle hole and from corner of test block — Note, step 8.

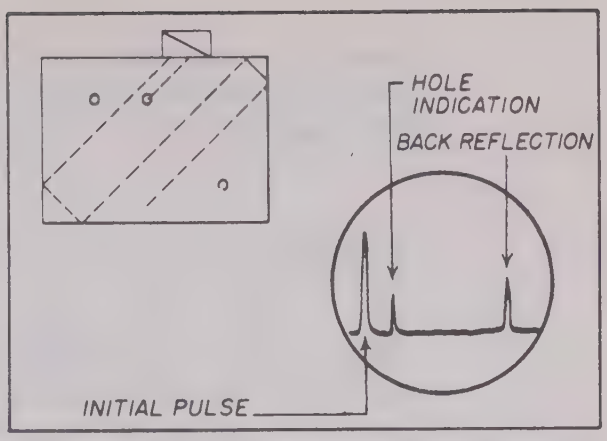
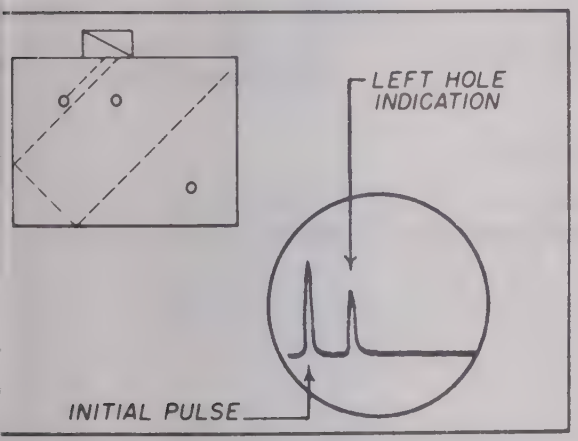


Figure 3–14 Increased return from middle hole and decreased return from corner results in a pattern as above — step 9.



gure 3–15 Reflection from small left hand hole — step 10.

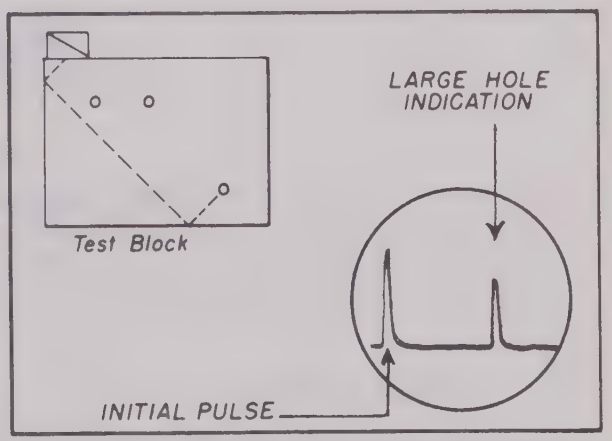
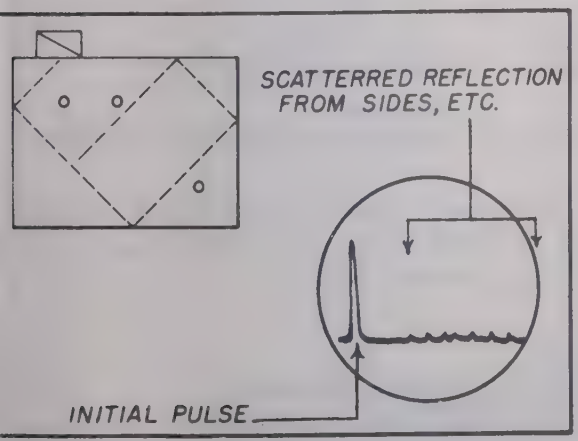


Figure 3–16 Reflection from large hole at lower right — step 10.



igure 3–17 No reflections are obtained when the searching unit is in the position shown above.

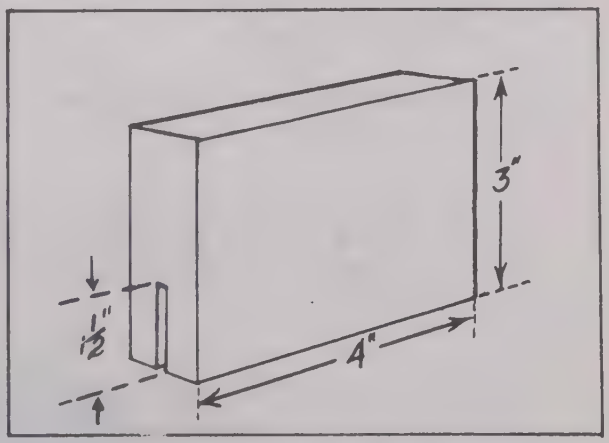


Fig. 3– Aluminum block with saw cut notch.

c. Connect one end of a 4' 8" cable to the receptacle marked "T". A 2.25 mc search unit is connected to the end of the second cable. (See Figure 3-19.)

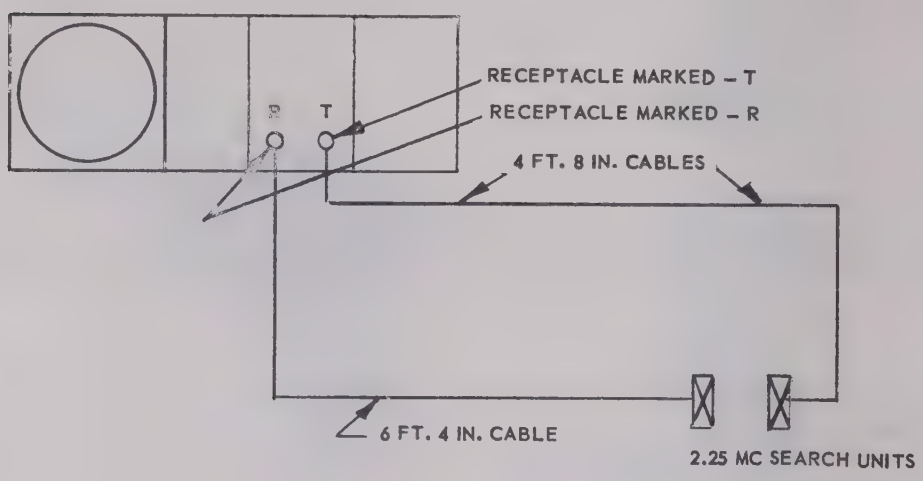


Figure 3–19

Cable Connections for Two Crystal (Through-Transmission) Testing

d. Set controls as follows:

(1) Sweep	1 x .1
(2) Reject	OFF
(3) Pulse Length	OFF
(4) Frequency	2.25
(5) Sensitivity	3
(6) Markers	OFF
(7) Test	THRU (transmission)
(8) Sensitivity Multiplier	x .1
(9) Pulse Tuning	Adjust for maximum signal amplitude.

e. Position the two search units on opposite sides of the block so that sound travels through the block in a direct line from the transmitting search unit to the receiving search unit.

NOTE

The CRT display shows indications from two sources, the initial pulse (transmitting search unit) and the sound striking the receiving search unit. (See Figure 3-20).

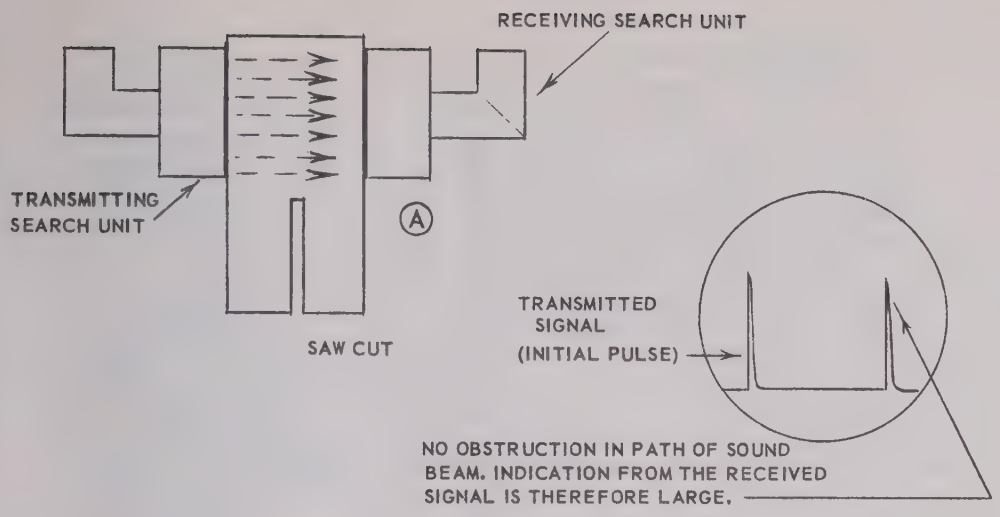

RECEIVING SEARCH UNIT
TRANSMITTING SEARCH UNIT
A
SAW CUT
TRANSMITTED SIGNAL (INITIAL PULSE)
NO OBSTRUCTION IN PATH OF SOUND BEAM. INDICATION FROM THE RECEIVED SIGNAL IS THEREFORE LARGE.

Figure 3–20

Through Transmission – Position A

f. Move search units to position B (Figure 3-21). Note that the indication from the receiving search unit is reduced in size or completely deleted. The sound travelling through the block is obstructed by the saw cut and, therefore, less energy reaches the receiving search unit.

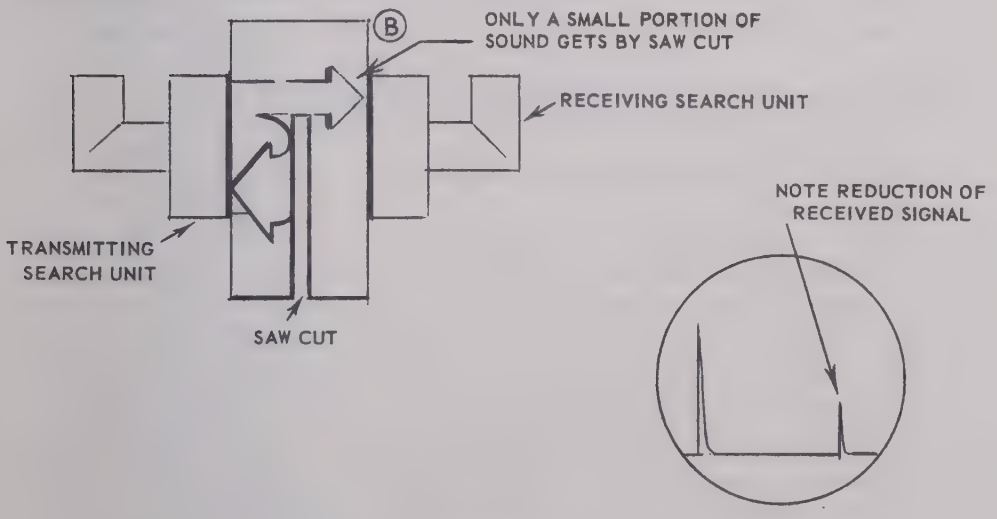

B
ONLY A SMALL PORTION OF SOUND GETS BY SAW CUT
RECEIVING SEARCH UNIT
NOTE REDUCTION OF RECEIVED SIGNAL
TRANSMITTING SEARCH UNIT
SAW CUT

Figure 3–21

Through Transmission – Position B

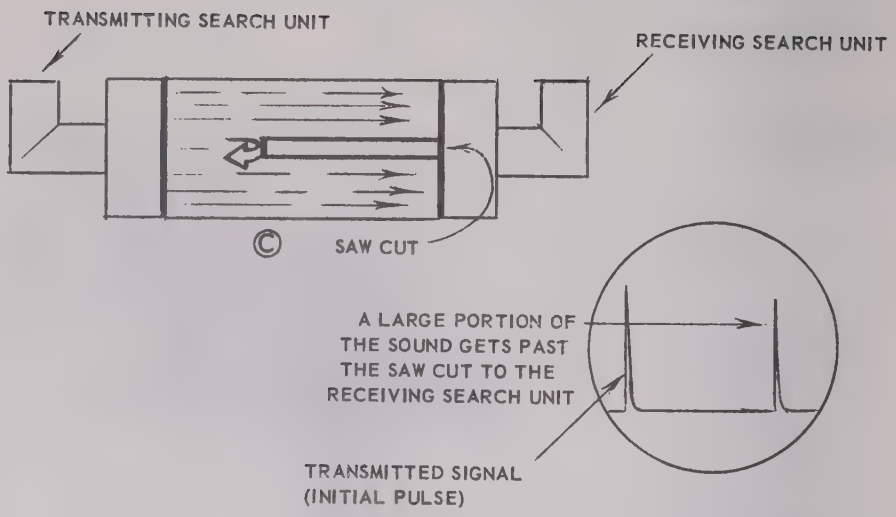

TRANSMITTING SEARCH UNIT
RECEIVING SEARCH UNIT
SAW CUT
A LARGE PORTION OF THE SOUND GETS PAST THE SAW CUT TO THE RECEIVING SEARCH UNIT
TRANSMITTED SIGNAL (INITIAL PULSE)

Figure 3-22
Through Transmission – Position C

g. Place search units at position C (Figure 3-22). Adjust sweep length until indication appears at right of CRT. Note that the indication from receiving search unit is of greater amplitude than at position B. The saw cut presents less obstructing area scanned from position C than it does when scanned from position B; therefore, it must be borne in mind that even a small loss of amplitude of the received signal may be caused by a large discontinuity if the plane in which it lies is not normal to the sound beam.

6. SINGLE SEARCH UNIT IMMERSION TESTING

a. Assemble the following equipment:

(1) Immersion tank.
(2) Search unit positioner carriage.
(3) Search unit positioner.
(4) Immersion search units.
(5) Search unit handles.
(6) Standard 6' 4" search cable.
(7) Long search cable (25 feet).
(8) Match networks (as required).
(9) Test block.

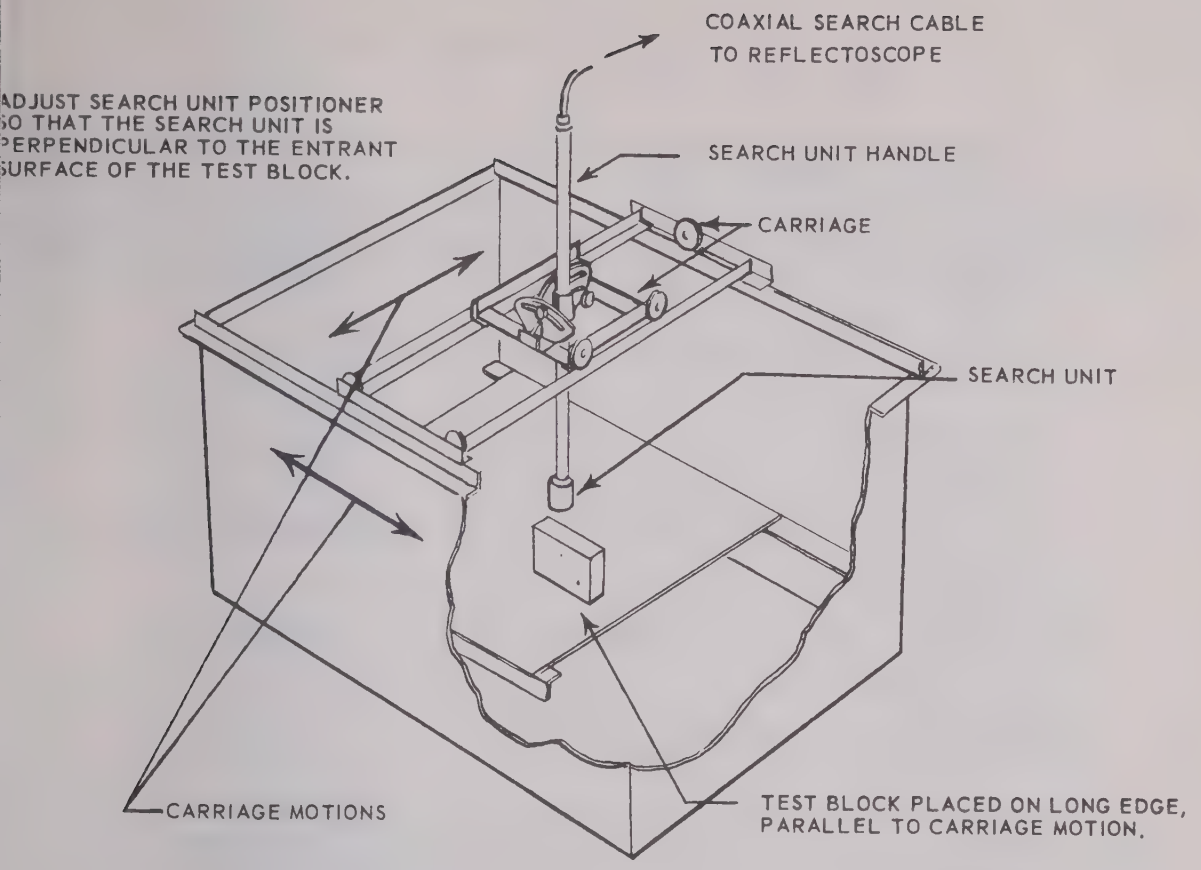


Figure 3–23

Arrangement of Accessory Equipment for Single Search Unit Operation

b. Mount search unit positioner carriage on tank. (Figure 3-23).

c. Mount positioner on carriage.

d. Assemble 5.0 mc 3/8" SI quartz search unit to a search unit handle, being sure "O" ring on search unit is in place.

e. Attach standard 6' 4" cable to search unit handle.

f. Attach other end of cable to receptacle marked "R" on Reflectoscope front panel.

NOTE

Turn connecting rings on search unit cable finger tight only.

g. Place test block in tank so that it is parallel to one of the carriage motions. (Figure 3-23).

h. Adjust positioner so that search unit is approximately 1 3/4" above surface of test block. (Figure 3-23).

i. Set front panel controls to following positions:

(1) Frequency	- 5.0 mc
(2) Sensitivity	- 2
(3) Pulse Length	- minimum.
(4) Pulse Tuning	- tune for maximum signal amplitude.
(5) Sweep	- 2 x 1
(6) Reject	- OFF
(7) Sweep Delay	- Initial pulse at first index mark.
(8) Markers	- OFF
(9) Test	- NORMAL
(10) Sensitivity Multiplier	- x1.

j. Position search unit by moving it over a section of the test block so that the sound beam will encounter no hole. Adjust the angular position of the search unit to obtain a signal of maximum amplitude from the bottom and top surface of the test block. (Figure 3-24).

k. Notice signal at left side of CRT. This is the initial pulse and is always visible unless more sweep delay is used.

l. The next large signal to the right of initial pulse is the surface signal or top surface of test block. The distance between the two signals is the distance the sound travels in water. (Figure 3-25).

m. Switch dial switch to Preset. This calibrates the sweep for water velocity. Set Sweep for 2 x .1 or 2 inches/div. Measure the distance from initial pulse to interface. Should be at most 9 divisions or 1.75".

n. Reset lever switch to 2 x 1 inches/div.

o. The next signal after the interface indication is the first back reflection representing the bottom of the test block. The second signal to the right of the interface indication is the second back reflection. Observe a signal to the right of the second back reflection. This is the second interface signal, i.e., it is a signal from

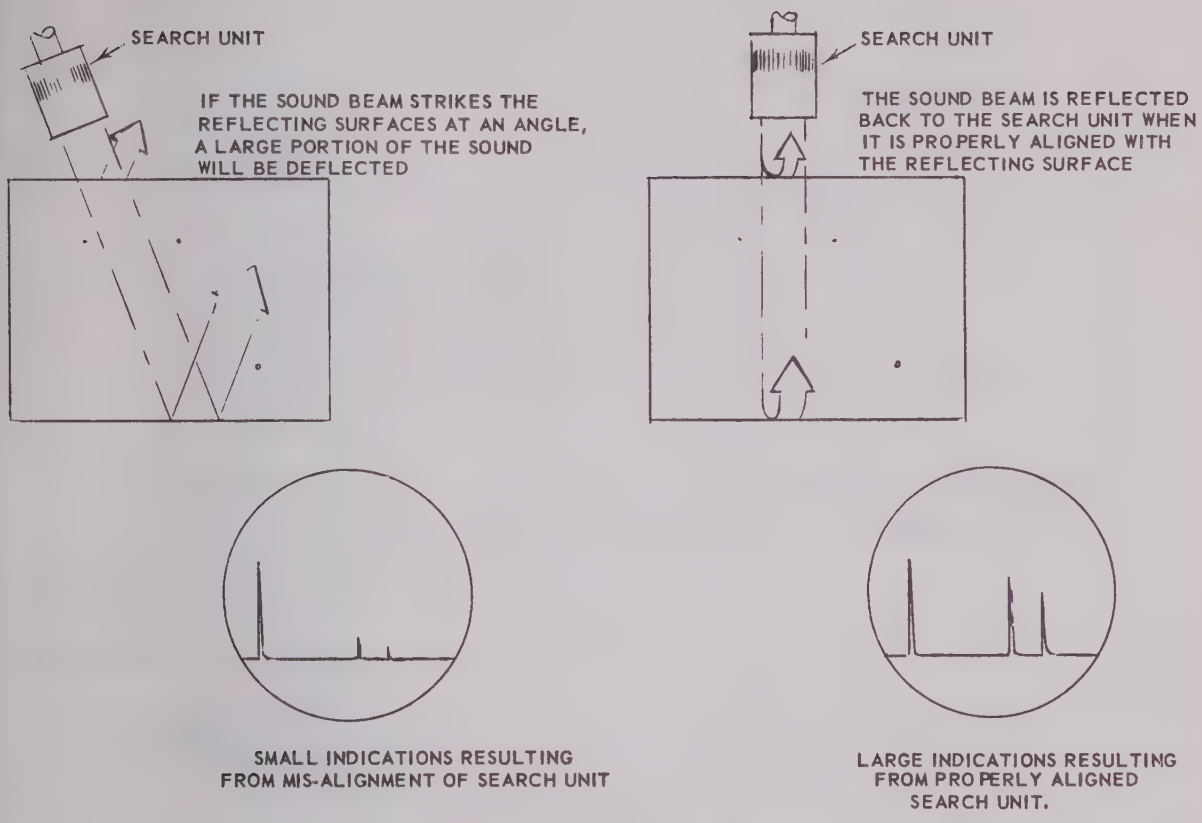

SEARCH UNIT
IF THE SOUND BEAM STRIKES THE REFLECTING SURFACES AT AN ANGLE, A LARGE PORTION OF THE SOUND WILL BE DEFLECTED
SEARCH UNIT
THE SOUND BEAM IS REFLECTED BACK TO THE SEARCH UNIT WHEN IT IS PROPERLY ALIGNED WITH THE REFLECTING SURFACE
SMALL INDICATIONS RESULTING FROM MIS-ALIGNMENT OF SEARCH UNIT
LARGE INDICATIONS RESULTING FROM PROPERLY ALIGNED SEARCH UNIT.

Figure 3–24

Positioning Search Unit for Maximum Penetration

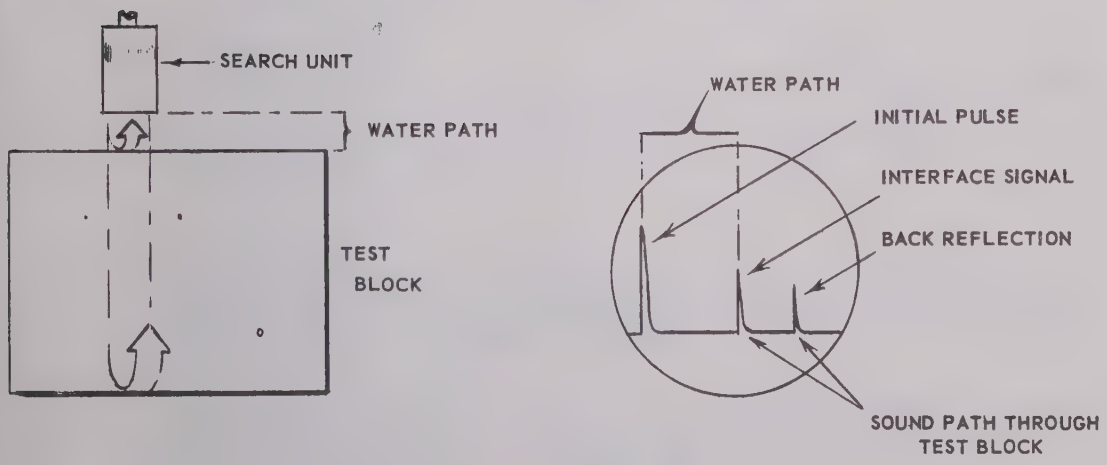


Figure 3–25

Sound Path Through Water and Test Block

the sound energy which has made two trips from the search unit to the top surface of the block and back. (Figure 3-26).

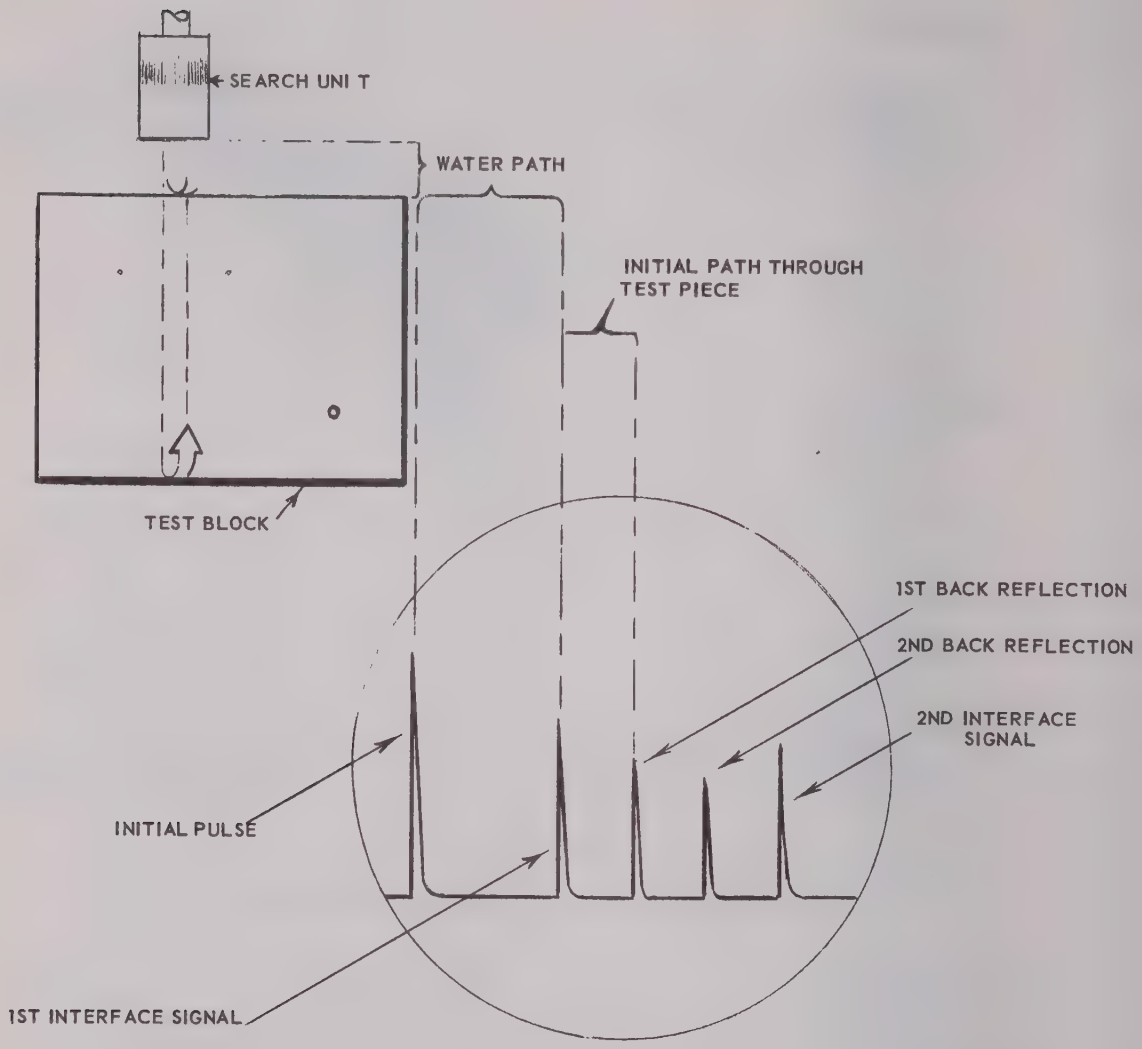


Figure 3–26
Signal Identification

NOTE

At this point, vary the water distance by moving search unit to and away from the test block. Observe that the distance between initial pulse and the interface signal varies and that the distance between the interface and the back reflection remains constant. The reason that the distance between the SU and top surface of reference block appears on the CRT as longer than the distance between top and bottom surfaces of the block, is that the velocity of sound through steel or aluminum is approximately 4 times that of the velocity of sound through water. Having identified these signals, position search unit so that the second interface echo falls to the right of the first back reflection.

p. Rotate Sweep Delay cw until first interface signal is at the left end of sweep line. (This eliminates initial pulse and water path from CRT screen.) (Figure 3-27).

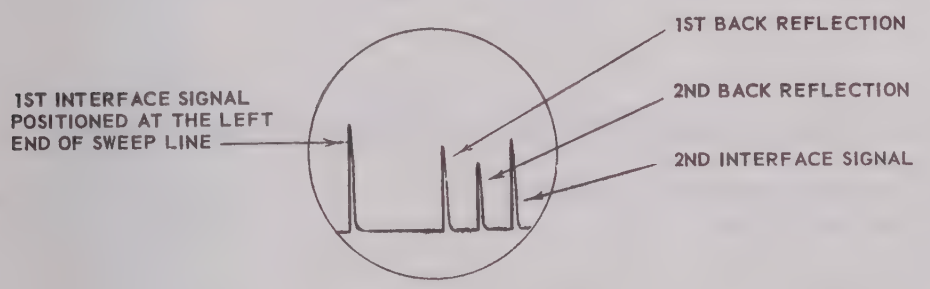

1ST BACK REFLECTION
2ND BACK REFLECTION
2ND INTERFACE SIGNAL
1ST INTERFACE SIGNAL POSITIONED AT THE LEFT END OF SWEEP LINE

Figure 3-27

Elimination of Initial Pulse and Water Path from CRT Screen

q. Adjust Sweep to move first back reflection to the right end of the sweep line, thus presenting on the CRT only the material depth. (Figure 3-28).

r. Move positioner over holes in block observing signals appearing between interface and back reflection, increasing sensitivity for desired signal amplitude.

s. Measurement of depth within the piece may be accomplished by the use of square wave markers. Align square wave markers with the leading edge of the interface signal instead of the initial pulse.

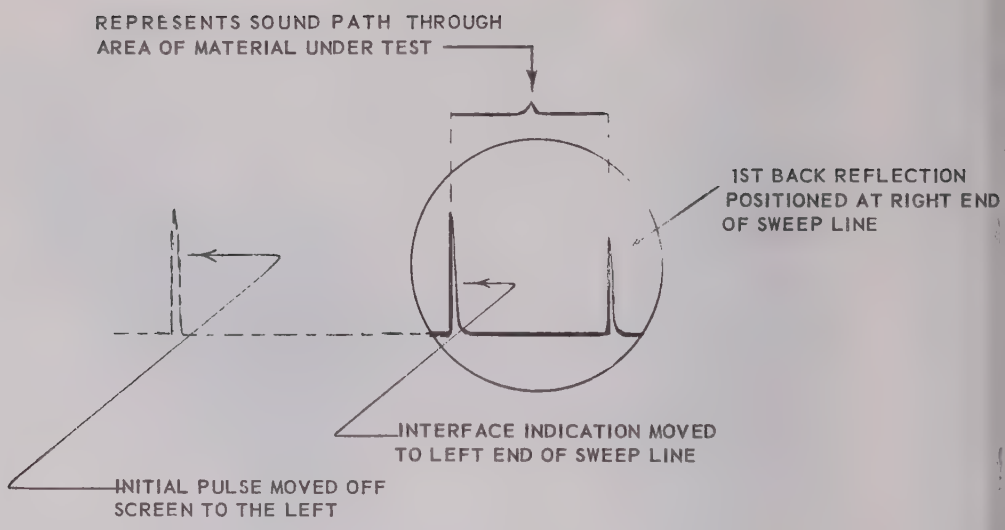

REPRESENTS SOUND PATH THROUGH
AREA OF MATERIAL UNDER TEST
1ST BACK REFLECTION
POSITIONED AT RIGHT END
OF SWEEP LINE
INTERFACE INDICATION MOVED
TO LEFT END OF SWEEP LINE
INITIAL PULSE MOVED OFF
SCREEN TO THE LEFT

Figure 3–28
Use of Sweep Delay Position Interface Signal
at Start of CRT Display

7. THROUGH-TRANSMISSION IMMERSION TESTING

a. In addition to the equipment listed in 6.a. preceeding, assemble the following:

(1) Standard 6' 4" search cable.
(2) Search unit handle.
(3) Two right angle adapters.
(4) Search units (both of the same frequency).
(5) A fixture to hold search handles in place (Figure 3-29). This is a suggested method of securing two search units on the tank if two positioners are not available.
(6) Test block with saw cuts. (Figure 3-30).

NOTE

Keeping the saw cut water tight by sealing with tape will result in easier signal interpretation.

b. Mount search unit adapters, search unit handles and po· ioning fixture on tank. Place aluminum block in tank as show: Figure 3-31

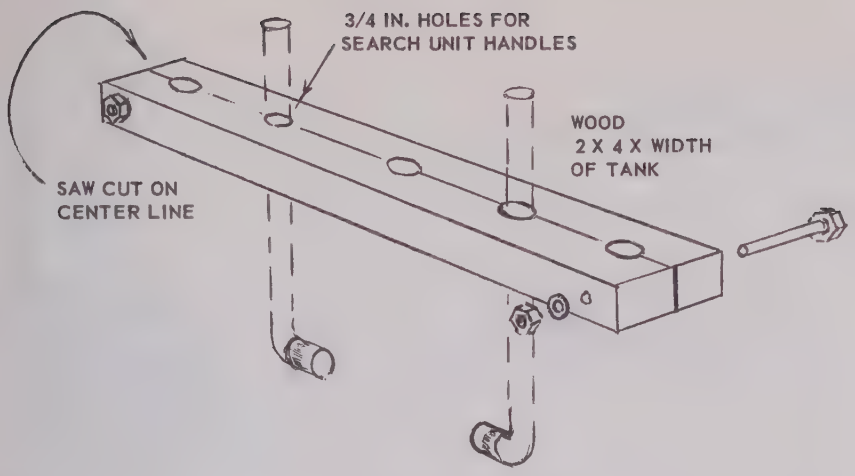


Figure 3-29
S.U. Positioning Fixture

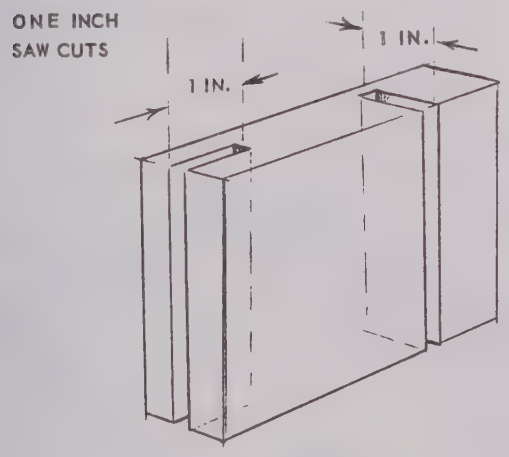


Figure 3-30
Aluminum Block

c. Connect one end of a standard 6' 4" cable to receptacle marked "R" and the other end to one of the search unit handles.

d. Connect one end of the second 6' 4" cable to receptacle marked "T" and the other end to the second search unit handle

e. Set front panel controls to following positions:

(1) Sweep delay - set initial pulse on first index mark
(2) Sweep - as required.
(3) Reject - OFF
(4) Pulse length - ccw
(5) Frequency - 2.25 mc
(6) Sensitivity - 1

(7) Markers - OFF
(8) Test - THRU
(9) Sensitivity Multiplier - x 1

f. Method of aligning Search units:

(1) Search units must be properly aligned so that the sound projected by the transmitting search unit will strike the receiving search unit. The CRT display shows indications from only two sources, the initial pulse and the sound striking the receiving crystal. This received signal must be brought to its optimum point by adjusting the search units until the greatest amount of the transmitted sound reaches the receiving search unit. (Figure 3-32).

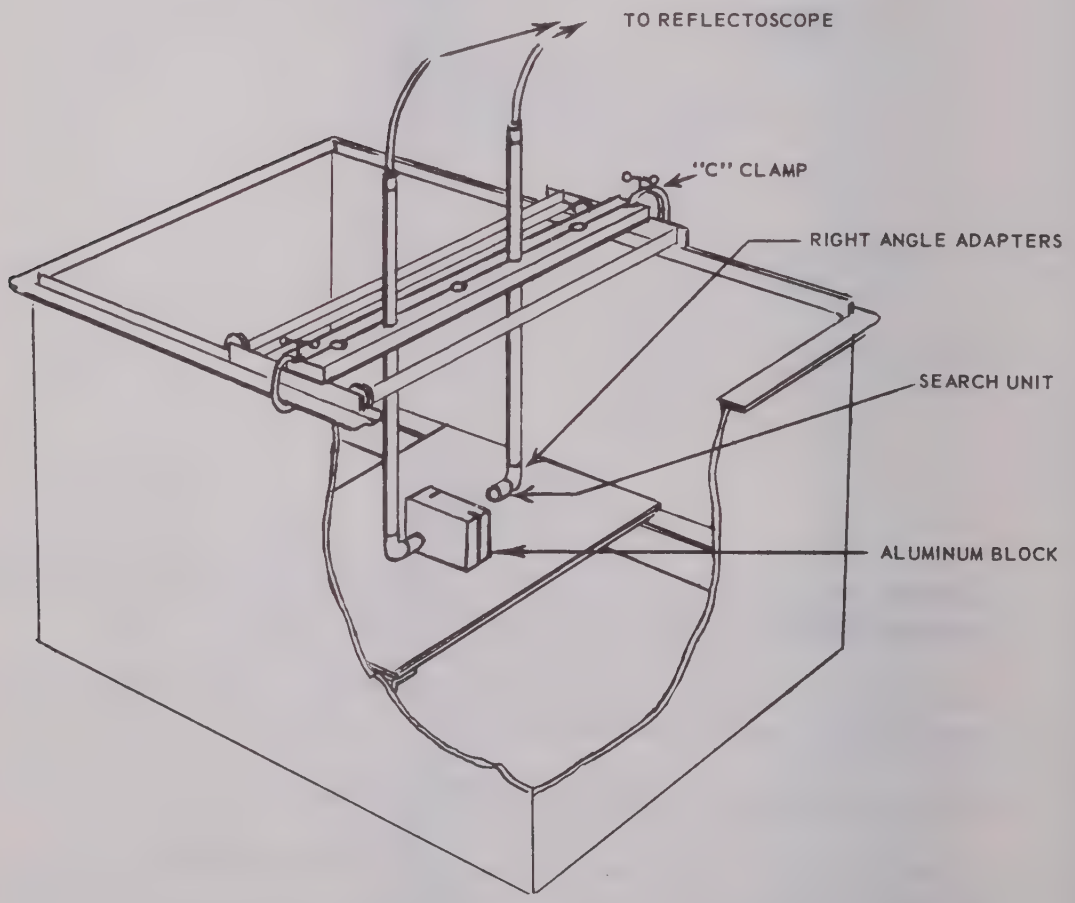


Figure 3-31
Arrangement of Accessory Equipment for Through Transmission

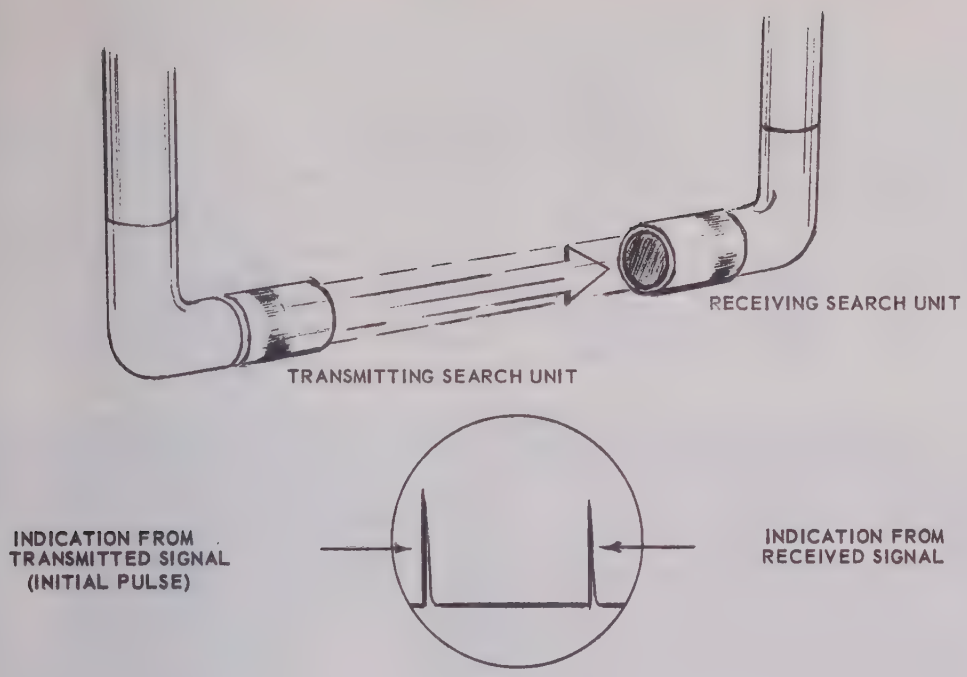

RECEIVING SEARCH UNIT
TRANSMITTING SEARCH UNIT
INDICATION FROM TRANSMITTED SIGNAL (INITIAL PULSE)
INDICATION FROM RECEIVED SIGNAL

Figure 3-32

Received Signals From Correctly Aligned Search Units

(2) Position search units so that the sound is directed at saw cut A. (Figure 3-33). Note that the indication from the received signal is reduced in size according to the amount of sound cut off by the saw cut (plan view).

(3) Position search units so that sound is directed at end of saw cut B. (Figure 3-34). Note that although the saw cuts are of equal dimensions, the indication is much larger when sound is directed at saw cut B. The plan view in Figure 3-34 shows only a small portion of the sound being obstructed by the narrow face presented by the saw cut B.

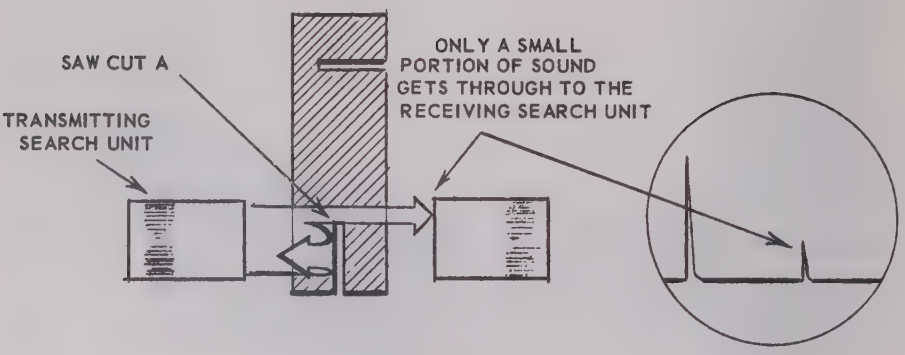


Figure 3–33

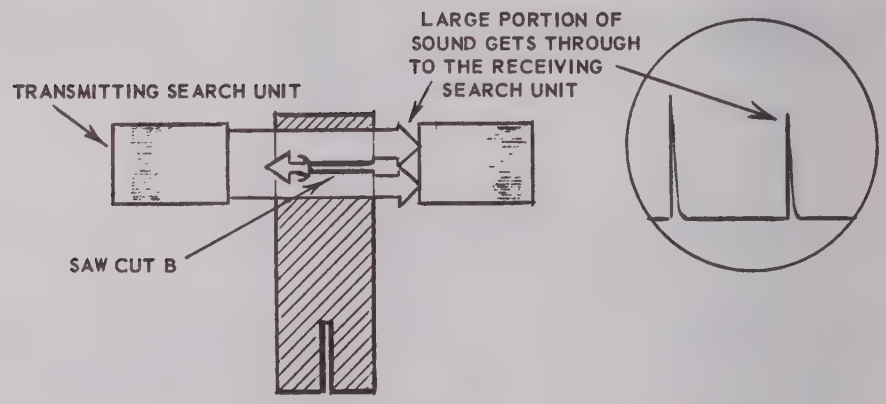


Figure 3–34

SECTION IV

UM 715 AND UM 721 DISPLAY/TIMER UNIT

DESCRIPTION

1. GENERAL (Figure 4-1)

The Display/Timer unit is an integral part of the instrument frame; the unit provides all timing, power and cathode ray tube display requirements for overall instrument function and consists of the following major components:

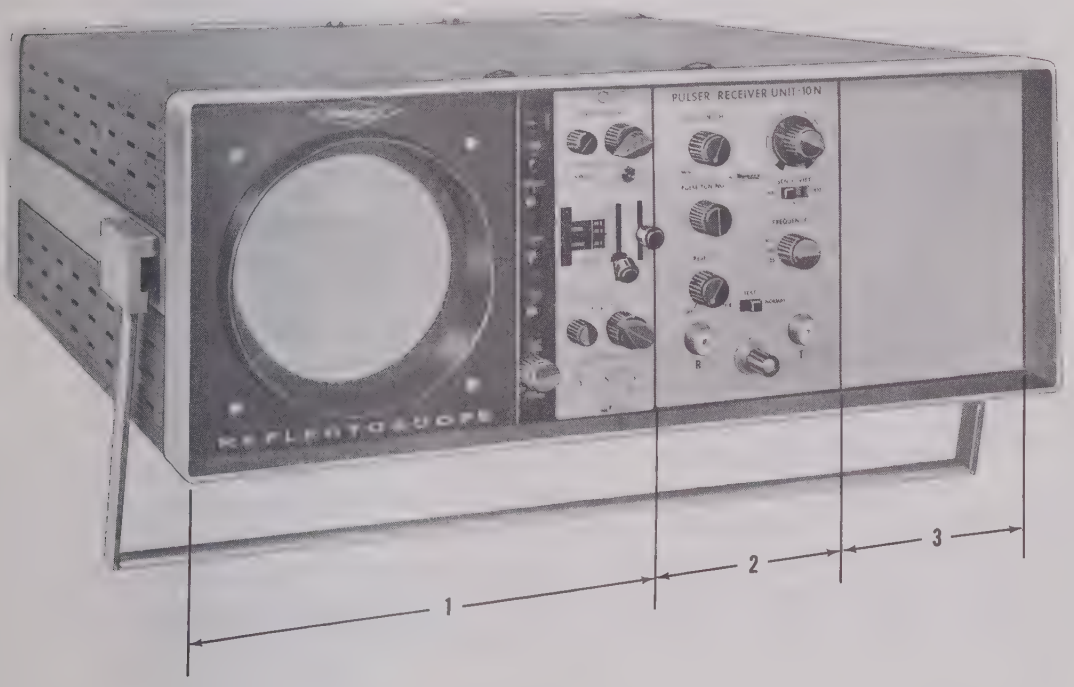


Figure 4-1
Display/Timer Unit

a. POWER SUPPLY

The Reflectoscope power requirements are stamped on the nameplate located on the rear of the cabinet. Strick adherence to specified requirements is essential to proper operation of the instrument. Built-in voltage regulators insure that line voltage fluctuations within limits specified on nameplate; will not affect the accuracy of indications. Fuses, power connections and special function chassis plug, are located at the rear of Reflectoscope cabinet.

CAUTION

1. Do not use Direct Current.
2. Fuse ratings should be followed exactly.

b. DEFLECTION AMPLIFIER BOARD

This board contains the final vertical and horizontal deflection amplifiers. The output of the amplifiers drives the vertical and horizontal deflection plates of the cathode ray tube.

c. HIGH VOLTAGE BOARD

This board contains the regulated high voltage supply and the unblanking amplifier. The high DC voltages required for the operation of the CRT are provided by the high voltage supply.

d. CATHODE RAY TUBE

Flat-faced 5-inch CRT with full screen, edge-lighted graticule.

e. TIMER BOARD

The circuitry on this board provides synchronizing signals for the Pulser/Receiver; for the generation of the horizontal time base sweep; for shifting and controlling the alternate trace; for controlling the sweep delay; and for the spike marker generator. The timer board also automatically sets the pulse rate for maximum trace brightness at any timer control setting.

2. FRONT PANEL CONTROLS

The operating controls for the Display/Timer are located on the front panel. The controls are in two categories, the display controls and the timing controls. The display controls are all screw-driven adjustments except the SCALE ILLUM. and POWER. The screw-driver controls generally require infrequent adjustment after the initial setting by the operator. The controls and their functions are:

a. DISPLAY

VERT - This screwdriver adjustment controls the vertical positioning of the display on the CRT.

HORIZ - This screwdriver adjustment controls the horizontal positioning of the display on the CRT.

INTENSITY - Varies the brightness of the CRT display and should be set for desired conditions. This is a screwdriver adjustment.

CAUTION

Too high a setting of intensity will burn a hole in the phosphor of the CRT. Adjust so that bright spot at left end of sweep is barely visible.

FOCUS

Adjusts the focus of the CRT and should be set for sharpness of trace. This is a screwdriver adjustment.

ASTIG

The astigmatism screwdriver control corrects for any distortion introduced by changing transit time of electron beam across CRT face.

POWER AND SCALE ILLUM

This dual control turns power on for entire unit - clockwise rotation adjusts scale illumination for display of grid lines.

b. TIMING

SWEEP DELAY

There are three controls in this group; a four position switch and two potentiometers. The switch provides three coarse delay ranges and an I.F. SYNC position. The latter position is operative only when an accessory Transigate is used and allows the sweep to be started concurrent with the appearance of an interface (I.F.) or first echo signal. The fine control potentiometer is mounted on the concentric shafted with the switch. The VERNIER control is a separate potentiometer. Total delay range is zero to four feet of steel.

SWEEP

Four controls comprise this group, two lever switches, a drum dial and a two-position toggle switch. The lever switches permit selection of nine sweep ranges calibrated in inches. The left lever switch has ranges of 1, 2, and 5 inches per division; the right lever switch is a multiplier, and multiplies the 1, 2, and 5 inch ranges by .1, 1, and 10. Thus sweeps in 1, 2, and 5 increments are available over a range of .1 inch per division to 50 inches per division.

The drum dial will provide an approximate calibration for most commonly used materials. For most work, where precise measurement is not required, the drum dial will be sufficiently

accurate. However, since velocities vary in different types of the same material, an accurate calibration can be obtained by setting the dial with a sample of the material to be tested. This can be accomplished as follows:

1. Set the SWEEP DELAY so the initial pulse starts coincidentally with the first vertical index mark.

2. Place the search unit on a one inch sample of the material.

3. Set the lever switch to 1 x .1, and set the drum dial so the first echo starts at the tenth index division. Note the settings on the drum dial for future settings during test.

The two-position toggle switch selects dial control or internal preset control. In the DIAL position, the drum dial control is effective. In the PRESET position, the internal preset control is effective. The internal control is preset at the factory for water calibration to enable quick measurement of water path for immersed testing. The preset control can be adjusted for any desired calibration. Remove the top skin of the Reflectoscope. Adjust R517, behind the sweep delay switch for the desired setting. The potentiometer can be set for a specific material; for shear wave or angle beam velocity (dial calibration is longitudinal or straight-in velocity or for horizontal distance in an angle beam test.

MARKERS

This group of controls consists of a four position switch and fine controls on concentric shafts, and a separate VERNIER control. The switch has an OFF and three coarse marker positions. Fine and vernier control of the markers in each position of the switch is accomplished by the two knob controls.

ALT DISPLAY SHIFT

VERT

This screwdriver adjustment controls the vertical position of the alternate trace with respect to the main display trace. Thus, if markers are present, they can be positioned as desired. Without markers, the alternate trace can be used as a vertical index; this may be a reference block level indicator, or a Transigate alarm level indicator. As an example of this use assume a test is being performed to a #5 Alcoa block defect level. Position the alternate trace vertically to the amplitude obtained with this reference block.

During the test, any defect exceeding this level will be readily observed.

HORIZ

This screwdriver adjustment controls the horizontal position of the alternate trace. Use of this control permits accurate alignment of the markers with the initial pulse.

RATE

This screwdriver adjustment permits fine control over the pulse rate. The pulse rate is automatically set as a function of sweep length. To insure maximum display brightness, and sufficient time to display entire test area, the pulse rate varies over the range 1000 pulses per second (pps) when the sweep is set for .1 inch per division, to 100 pps when the sweep is set for 50 inches division. The RATE control permits reducing these rates in the range 100 pps at .1 inch per division to 50 pps at 50 inches per division.

3. INTERNAL CONTROLS

a. POWER SUPPLY CHASSIS

1. +150V DC ADJUSTMENT

   R121 controls the level of this output. This setting should not be made until the -108V DC supply has been checked. The -108V DC is used as a reference for the +150 volt regulator, and any variation in the -108 volt supply will affect the setting of R121.

2. +300V DC ADJUSTMENT

   R113 establishes the output level of the +300 volt supply. This adjustment should not be made until the +150 volt supply is adjusted since the +150V DC is used as the reference voltage for the 300 volt regulator.

3. -12V DC ADJUSTMENT

   R135 controls the output level of the -12 volt supply. This control is located on the small PC board mounted atop the power supply chassis.

4. +12V DC ADJUSTMENT

   R144 controls the output level of the +12 volt supply. The control is located on the same PC board as R135, the -12 volt adjustment.

5. HIGH VOLTAGE ADJUSTMENT
R123, located on the power supply chassis, controls the output of the high voltage rectifiers. The -108V DC and +150V DC supplies should be checked prior to adjusting R123 for -1.9KV

b. DEFLECTION AMPLIFIER BOARD

1. HORIZONTAL GAIN
R351 controls the horizontal gain and is to be adjusted for a sweep length just over 10 divisions on the CRT.

2. VERTICAL GAIN
R345 controls the amplitude of the signals displayed on the CRT. Set for a 2-3/4 inch height, or as desired.

c. TIMING BOARD

1. SWEEP CALIBRATION
Potentiometers R413, R417, R418 and R419 are used to calibrate the sweep. R413 is effective on all ranges; R417, R418 and R419 are effective on the 1, 2, and 5 positions of S502, respectively. The calibration is accomplished as follows:

a. Connect a 5 MC search unit fixed to a 1 inch aluminum block to the Pulser/Receiver. Adjust the receiver controls so that 10 or 12 clearly defined multiples appear on the CRT screen.

b. Set S502 to position I and S503 to position X .1. Adjust R417 until there are exactly 10 CM between the leading edges of successive multiples. Do not use the main bang. Adjust the fine and vernier sweep delay controls on the front panel until the first and second multiple span the entire 10 CM horizontal display.

c. If the end point of R417 is reached before calibration at this point is reached, adjust R413 so that calibration is achieved, plus 20° more rotation. Reset R417 so that calibration is again achieved.

d. Set S502 to position 2. Adjust R418 and the sweep delay controls until the leading edges of the second, third, and fourth multiples appear on the screen with exactly 5 CM spacing between each.

e. Set S502 to position 5. Adjust R419 and the sweep delay controls until the first, second, third, fourth, fifth, and sixth

multiples appear on the screen with exactly 2 CM spacing between each leading edge.

2. PRESET SWEEP

Potentiometer R517 is an internal control that allows the sweep generator to be preset for any material with velocity between 1400 and 6400 meters per second. This control is adjusted at the factory for 1490 meters per second, the approximate velocity of fresh water. This setting can be changed as follows:

a. Set the SWEEP DIAL-PRESET switch to PRESET.
b. Select a block of material, of known thickness, for which the presetting is desired and fix the search unit to it.
c. Set the scope controls to display the pattern on the CRT.
d. Set S502 and S503, the lever sweep switches to obtain a pattern as near full scale as possible.
e. Adjust R517 until the display registers the proper number of centimeters on the horizontal scale, matching exactly the known thickness of the test block.

4. CIRCUIT DESCRIPTION

The Display/Timer unit contains the power supplies, timer board, and the cathode ray tube and its associated circuitry. Interconnection between the Display/Timer and the associated Pulser/Receiver or other external units is accomplished through twenty-four pin connectors at the rear of the unit.

a. POWER SUPPLIES

1. LOW VOLTAGE SUPPLIES

Three regulated outputs are provided by the power supplies, -108V DC, +150V DC, and +300V DC; unregulated outputs of +325V DC, +380V DC, and +400V DC, are also provided. The power supplies are conventional silicon rectifier full wave bridge rectifiers. The regulator circuit for the -108V DC output uses gas diode V104. The -108 volts across this diode is used as the reference voltage for the +150 volt control amplifier V103. This controls the +150 volt regulator V102B. The regulated +150 volts is used as the reference voltage for the +300 volt control amplifier V101 which controls regulator V102A.

2. HIGH VOLTAGE SUPPLY

The high voltage supply consists of a 50 kilocycle oscillator, V201 with transformer T201 as its tank circuit. The secondary winding of this transformer is stepped up into V206, V205, and V204 high voltage rectifiers. This high voltage is filtered and

is then used to power the CRT. Some of this high voltage is sampled and amplified by V202 and then fed back into the screen grid of V201. Because of this feedback loop and the reference voltage at pin 3, V202, the high voltage will tend to remain constant regardless of beam current requirements of the CRT and line voltage shifts.

3. UNBLANKING AMPLIFIER V203

A negative square pulse is transmitted from the timer to the unblanking amplifier. Here it is inverted and amplified in one section of this tube. The other half of the tube is used to afford a low source impedance for the square pulse that is used to turn the cathode ray tube beam on for the duration of the sweep.

b. VERTICAL FINAL AMPLIFIERS

The final amplifiers for the vertical scale of the CRT use tubes V305, V303 and V304. V303 and V304 are two pentodes used as a self-inverting, high frequency compensated voltage amplifier, direct coupled to the vertical deflection plates of the CRT. The ultrasonic signals are applied to pin 2 of V303. V304 pin 2 is by-passed to ground through C306, For DC, however, the slider of R328 (vertical position) can be adjusted to position the spot or trace vertically on the CRT face. The screen grids of both V303 and V304 are direct coupled to dual triode V305 pins 3 and 8 V305 is used as a dual cathode follower to maintain the screen grids of V303 and V304 at a low impedance point and also to afford two extra input points to the CRT via the control grids of V305 These extra input points can be used to display supplementary signals such as markers and selector gates etc. on either or both the video and alternate sweeps.

c. HORIZONTAL FINAL AMPLIFIERS

The horizontal final amplifiers consist of tubes V301 and V302. Tube V301 is a pentode amplifier and cathode follower. The cathode follower is used to isolate the input capacities of V302 from the plate circuit of the pentode amplifier in V301. Tube V302 is a paraphase push-pull voltage amplifier direct coupled to the horizontal deflection plates of the CRT. Pin 2 V302 is AC short circuited to ground but the DC potential at this point can be varied with the slider of R318 (horizontal positioning). This positions the trace or spot horizontally on the CRT face.

d. TIMER BOARD 50D349

1. SWEEP AND SWEEP DELAY

The timer board contains the main horizontal display circuitry, and the alternate trace and markers circuitry. The main dis-

play circuitry consists of Q401 through Q408. When power is first applied, Q401 and Q402, which comprise the sweep delay one shot, and Q407 and Q408, the rate space one shot, all go into saturated conduction. The positive output of Q402 is applied through CR404 to the emitter of Q404. Transistor Q404 is used as a constant current sweep generator that charges C409, C410, or C411, depending upon the position of S503, at a linear rate in the positive direction. This positive-going sweep is applied through the emitter followers Q405 and Q406 to the output at pin 9 of J401.

Simultaneously the signal is inverted at the collector of Q406; the DC level of the inverted signal is shifted through CR408 and is applied through CR413 to the base of Q408, in the rate space one shot. The injection of this signal to Q408 must occur before the voltage at the collector and emitter of Q406 become nearly equal. When the inverted sweep (ramp) signal becomes great enough to pull Q408 out of conduction the rate space one shot, Q407 and Q408, regenerates into its temporary state. In this state, Q407 and Q408 are cut off. When the transition occurs, CR407 discharges the particular sweep timing capacitor, C409, C410, or C411. The diode continues to hold the sweep timing capacitor discharged until the rate space one shot completes its temporary cycle. The rundown time of Q407-Q408 is governed by R431 and C416. This time constant remains fixed. To vary the temporary state of this multivibrator, the initial charge on C416 is set by R506, the RATE control.

When Q407 and Q408 revert back to their stable state, CR407 releases the sweep timing capacitor, but no new sweep will be generated because the positive transition of Q407 collector triggered Q401 and Q402 into their temporary state, stopping the positive supply through CR404 to Q404. This prevents Q404 from generating a new sweep until the sweep delay one-shot has satisfied its time constants. When Q401-Q402 regenerate back to their stable condition, a new sweep cycle starts. This process is now repeated in ring counter fashion so that all three circuits, the sweep delay, sweep generator, and rate space, operating sequentially, form the basic repetition rate.

2. ALTERNATE TRACE AND MARKERS

These circuits include transistors Q411 through Q421, and generate the alternate trace display, gate the main display information or alternate display information, and generate the markers. For each positive transition at the collector of Q407, a trigger pulse

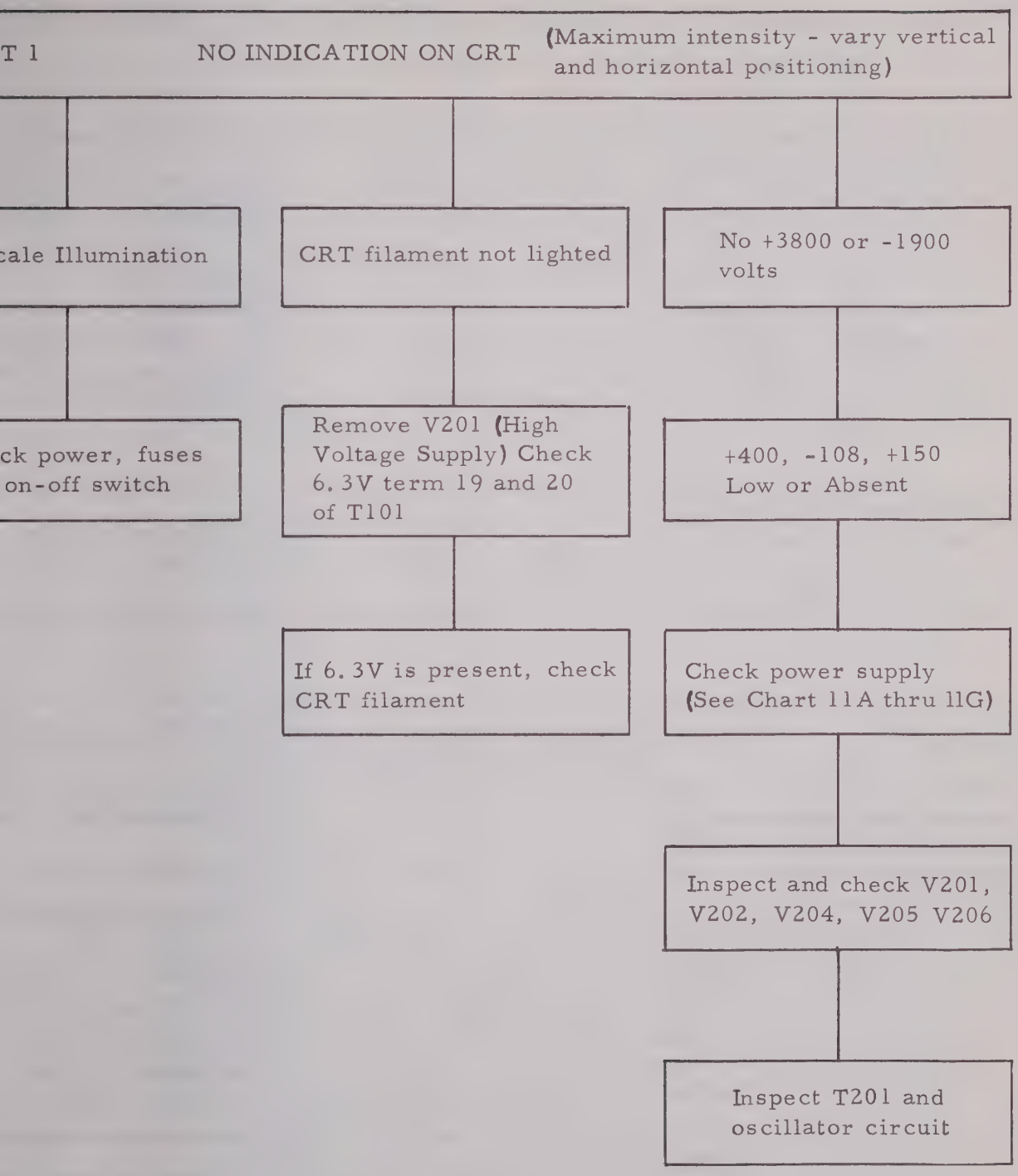
is injected into the bases of Q411 and Q412, the display divider flip-flop. This circuit divides the repetition rate by two. The display divider drives directly the display selector circuit consisting of Q413 and Q414. These transistors alternately select information from pin 5, J401 or pin 3, J401 depending on the bias condition on the bases of Q413 and Q414. In one condition, the line to pin 4, J401 is nearly the same potential selected at the arm of R509 or what ever information is on pin 3, J401 such as DAC signals etc. At this time Q413 is open and Q414 is closed. Alternately, when Q414 is open and Q413 is closed, pin 4, J401 is nearly the same potential as pin 5, J401. Transistors Q413 and Q414 work as a selector switch that alternately sends information to the vertical display system from either pin 5 or pin 3 via pin 4, J401.

The pulser delay regenerator, Q415 and Q416, is in sychronism with the display divider but is lagging in time by 30 microseconds. This delay is achieved by the integrating network consisting of R447, R446, R511, CR419 and C429 whose wave is added to the integrated wave generated by C427 and L401. CR419 compensates for the difference in driving impedance on positive and negative transitions of the display divider flip-flop. A -22 volt synchronizing signal is transmitted to the Pulser/Receiver via pin 6, J401 for each negative transition at the collector of Q412.

The gate markers isolation amplifier, Q417, decouples the high frequency marker signals from the preceding stages. It also, along with CR422 and CR426, helps to preset bias conditions on the marker generator stage, Q418 and Q419.

The marker generator is an astable multivibrator which is allowed to operate when ever Q417 turns off. Before this happens, bias conditions have been set so that the marker generator will start running with good symmetry even on the first half cycle of its waveform. The marker generator timing is selected by S504, MARKERS switch and R515, MARKERS coarse and vernier controls. A shaped trigger is derived from L402 and is applied through steering diodes CR427 and CR428 to trigger the marker flip-flop and output circuit, Q420 and Q421. This circuit divides the marker generator frequency by two, squares the waveform and maintains near perfect symmetry. The markers are then transmitted to pin 11, J401 and into the vertical system.

Q409 and Q410 are part of supply regulator circuitry that provides stable 12 volt operating and bias voltages to the circuit board.


T 1
NO INDICATION ON CRT
(Maximum intensity - vary vertical and horizontal positioning)
cale Illumination
CRT filament not lighted
No +3800 or -1900 volts
ck power, fuses on-off switch
Remove V201 (High Voltage Supply) Check 6.3V term 19 and 20 of T101
+400, -108, +150 Low or Absent
If 6.3V is present, check CRT filament
Check power supply (See Chart 11A thru 11G)
Inspect and check V201, V202, V204, V205 V206
Inspect T201 and oscillator circuit

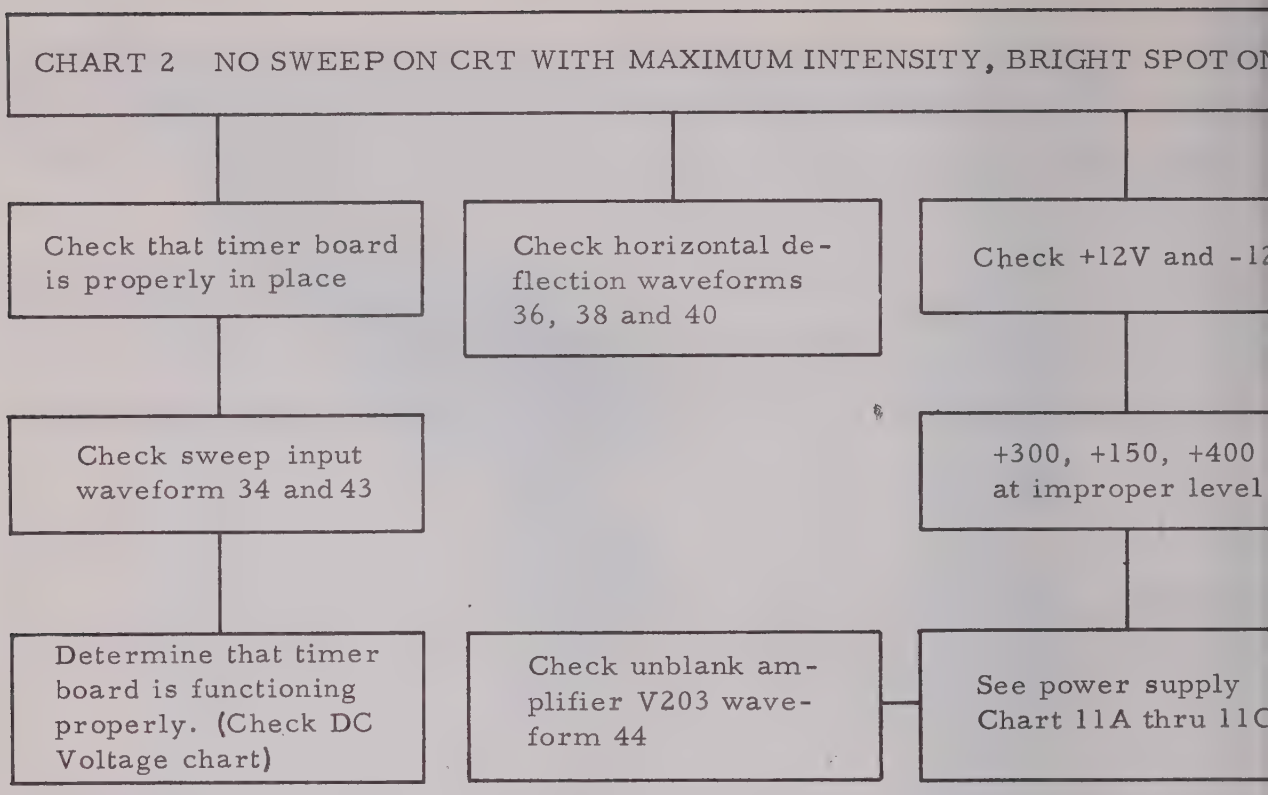


CHART 2 NO SWEEP ON CRT WITH MAXIMUM INTENSITY, BRIGHT SPOT ON
Check that timer board is properly in place
Check horizontal deflection waveforms 36, 38 and 40
Check +12V and -12
Check sweep input waveform 34 and 43
+300, +150, +400 at improper level
Determine that timer board is functioning properly. (Check DC Voltage chart)
Check unblank amplifier V203 waveform 44
See power supply Chart 11A thru 11C

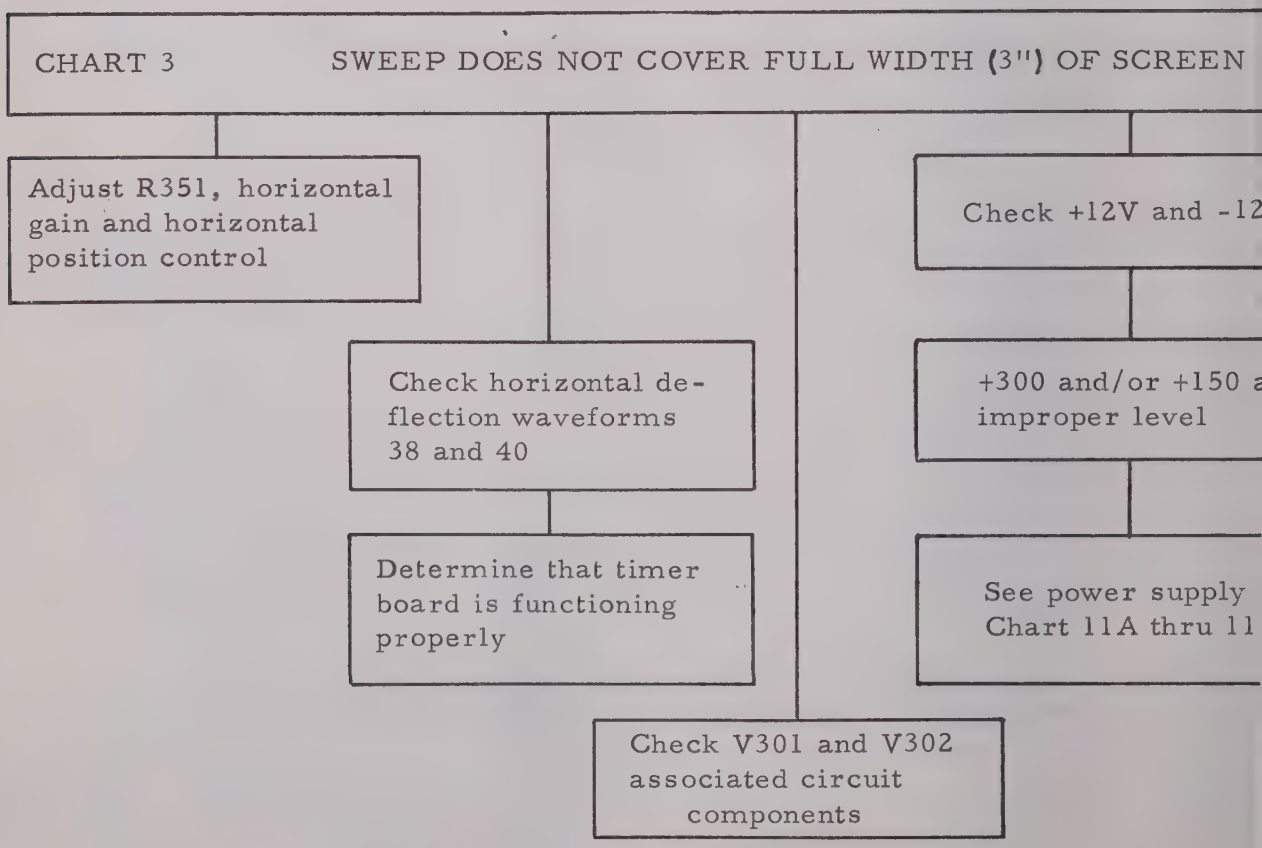
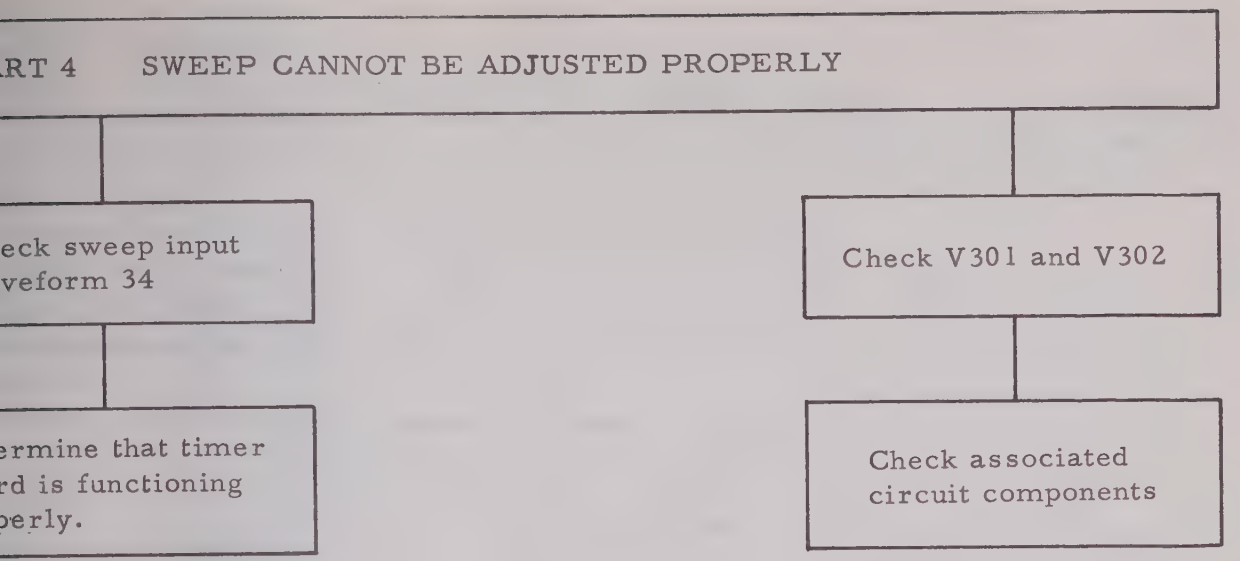
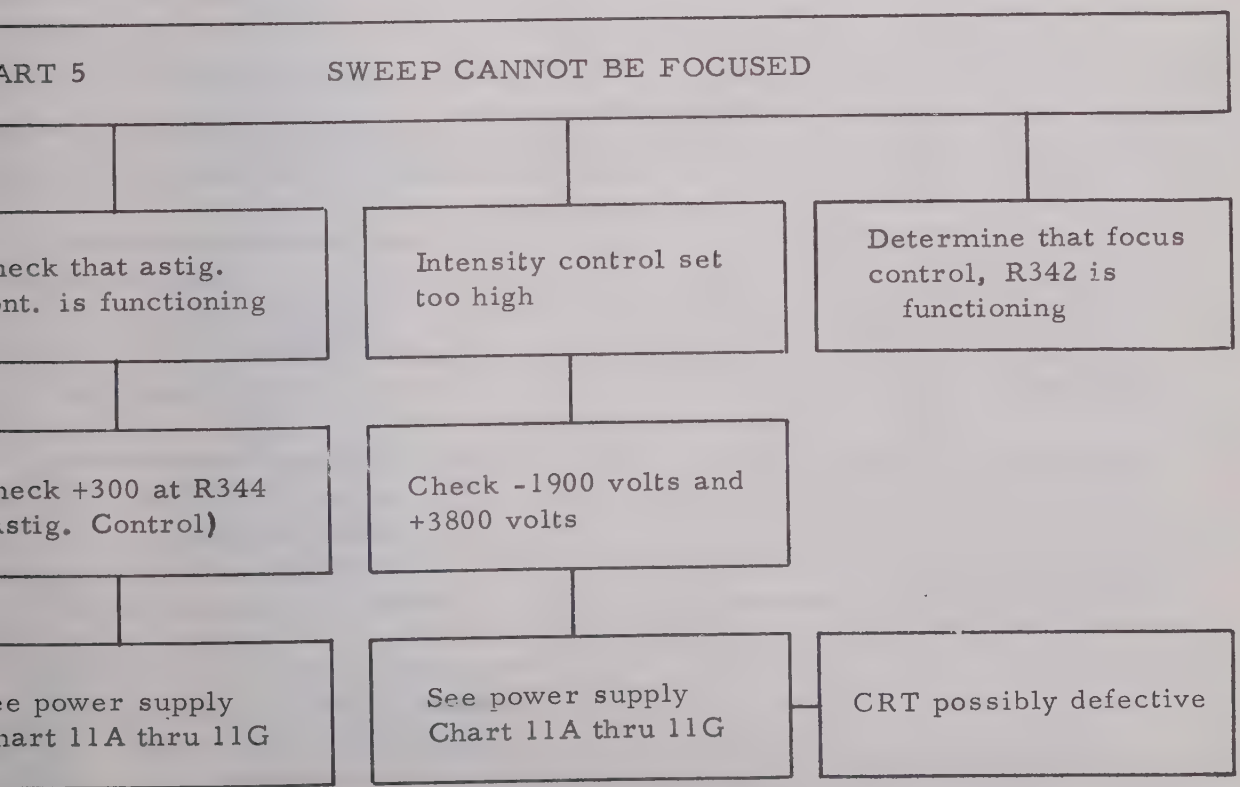


CHART 3 SWEEP DOES NOT COVER FULL WIDTH (3") OF SCREEN
Adjust R351, horizontal gain and horizontal position control
Check +12V and -12
Check horizontal deflection waveforms 38 and 40
+300 and/or +150 a improper level
Determine that timer board is functioning properly
See power supply Chart 11A thru 11
Check V301 and V302 associated circuit components


RT 4 SWEEP CANNOT BE ADJUSTED PROPERLY
eck sweep input veform 34
ermine that timer rd is functioning perly.
Check V301 and V302
Check associated circuit components


ART 5 SWEEP CANNOT BE FOCUSED
heck that astig. nt. is functioning
heck +300 at R344 stig. Control)
ee power supply hart 11A thru 11G
Intensity control set too high
Check -1900 volts and +3800 volts
See power supply Chart 11A thru 11G
Determine that focus control, R342 is functioning
CRT possibly defective

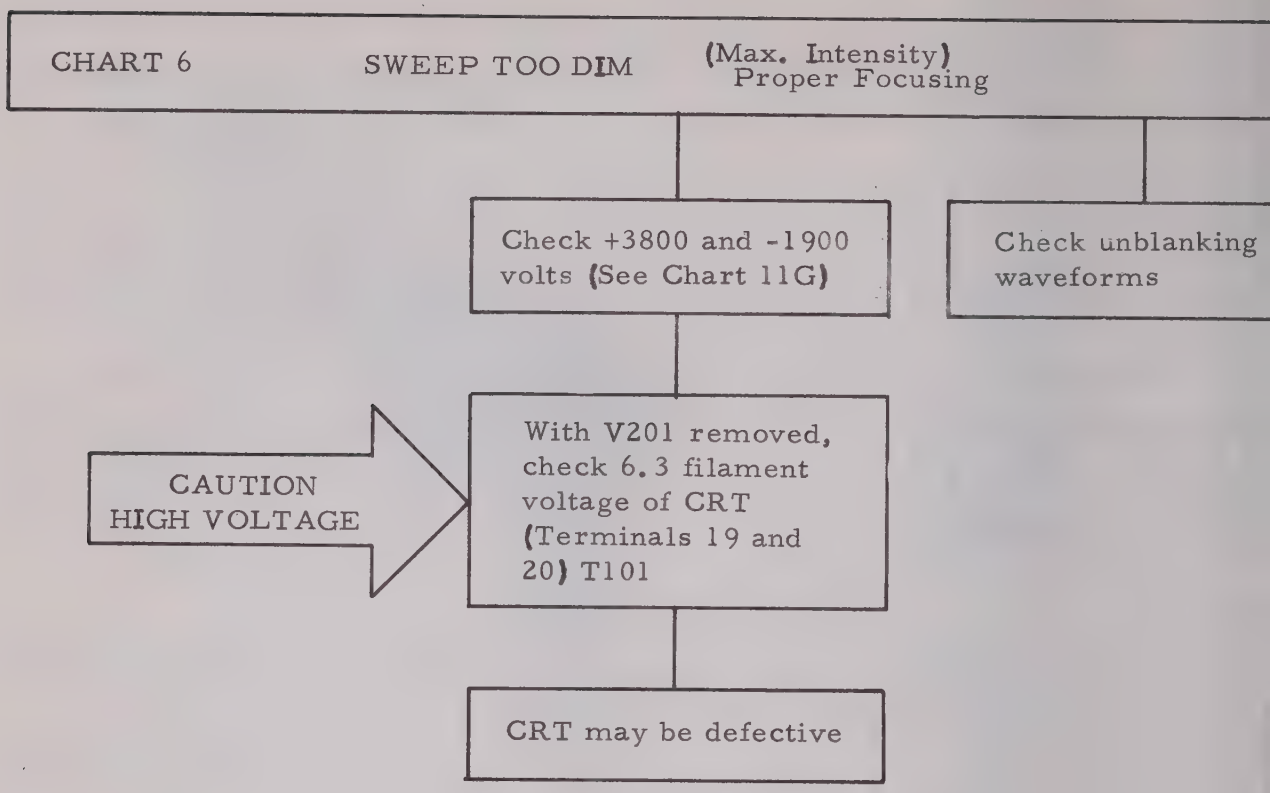


CHART 6
SWEEP TOO DIM
(Max. Intensity)
Proper Focusing
Check +3800 and -1900 volts (See Chart 11G)
Check unblanking waveforms
CAUTION
HIGH VOLTAGE
With V201 removed, check 6.3 filament voltage of CRT (Terminals 19 and 20) T101
CRT may be defective

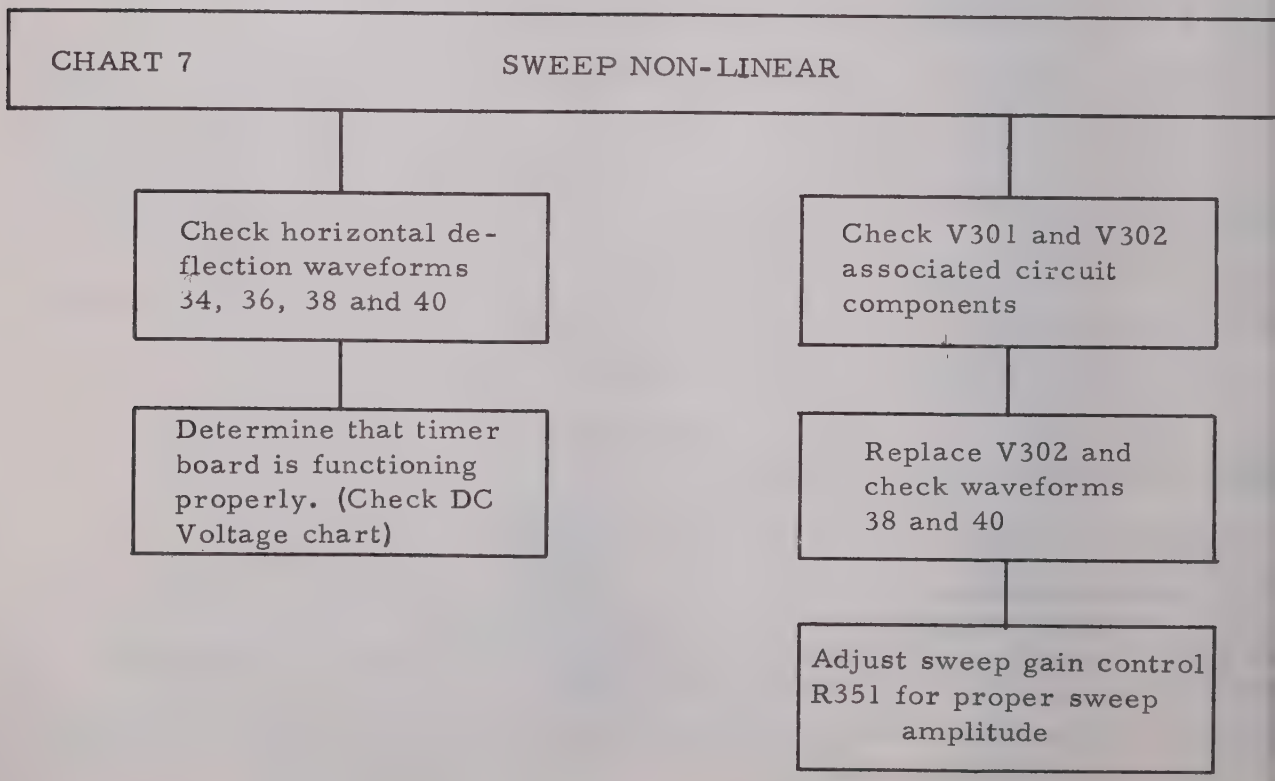


CHART 7
SWEEP NON-LINEAR
Check horizontal deflection waveforms 34, 36, 38 and 40
Determine that timer board is functioning properly. (Check DC Voltage chart)
Check V301 and V302 associated circuit components
Replace V302 and check waveforms 38 and 40
Adjust sweep gain control R351 for proper sweep amplitude

RT 8 SWEEP PRESENT BUT NO MAIN BANG (Transducer disconnected, sensitivity and pulse length at maximum, sweep delay and reject at minimum)

Check that Pulser/ Receiver unit is properly in place

eck video present at tical deflection amfier V303, pin 2

e Pulser/Receiver oubleshooting Chart Section VI

See DC Voltage Chart

Check vertical deflection amplifier waveforms 35, 37, 39 and 41

Check associated circuit components

RT 9 MAIN BANG VISIBLE BUT EITHER LOW SENSITIVITY OR NO SIGNALS

Change Search unit nd cables

Determine that Pulser/Receiver unit is functioning properly. (Refer to Pulser/Receiver troubleshooting chart in Section VI)

Determine that video section of timer is functioning properly

Check V303, V304, V305 or associated circuitry

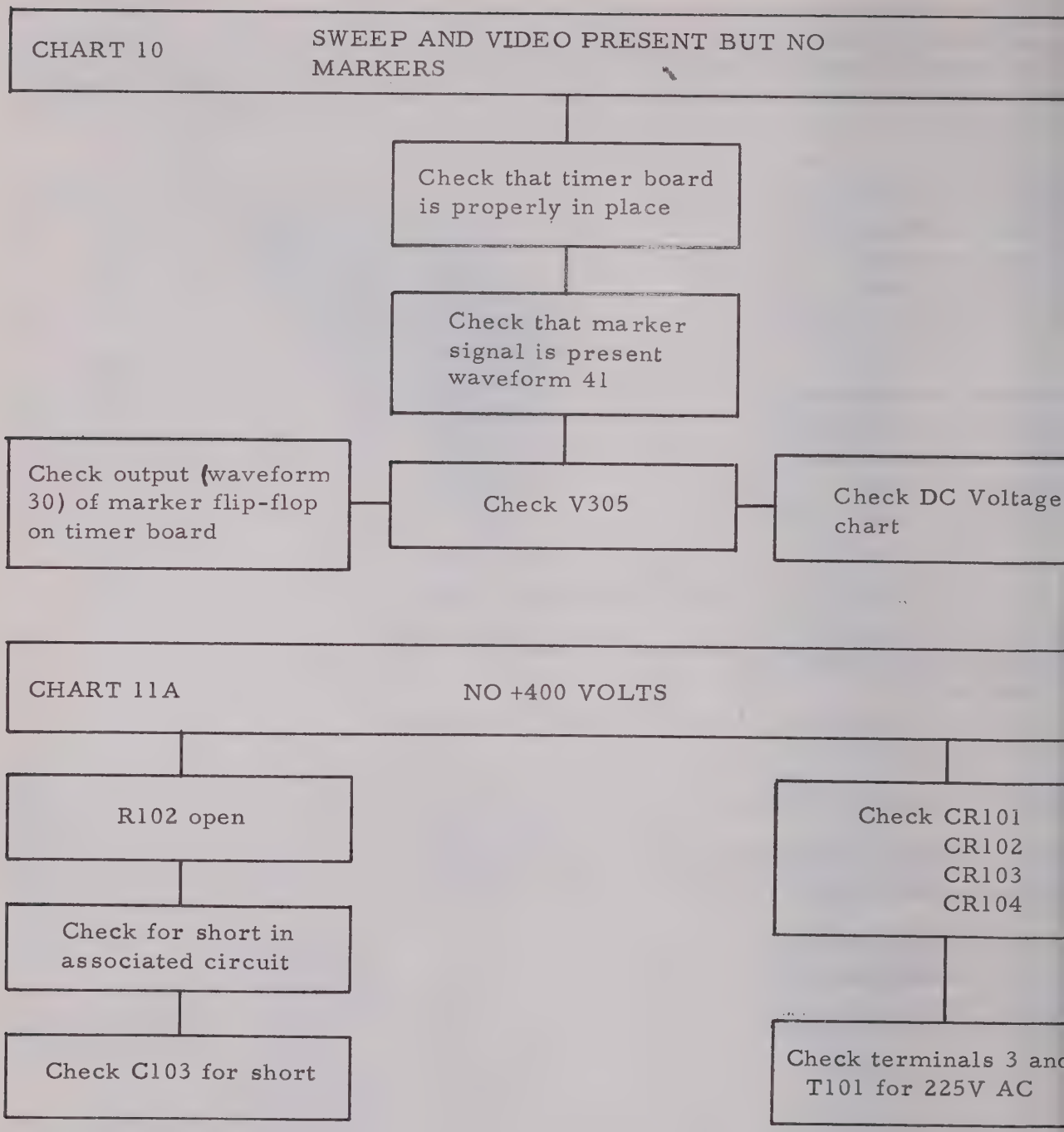
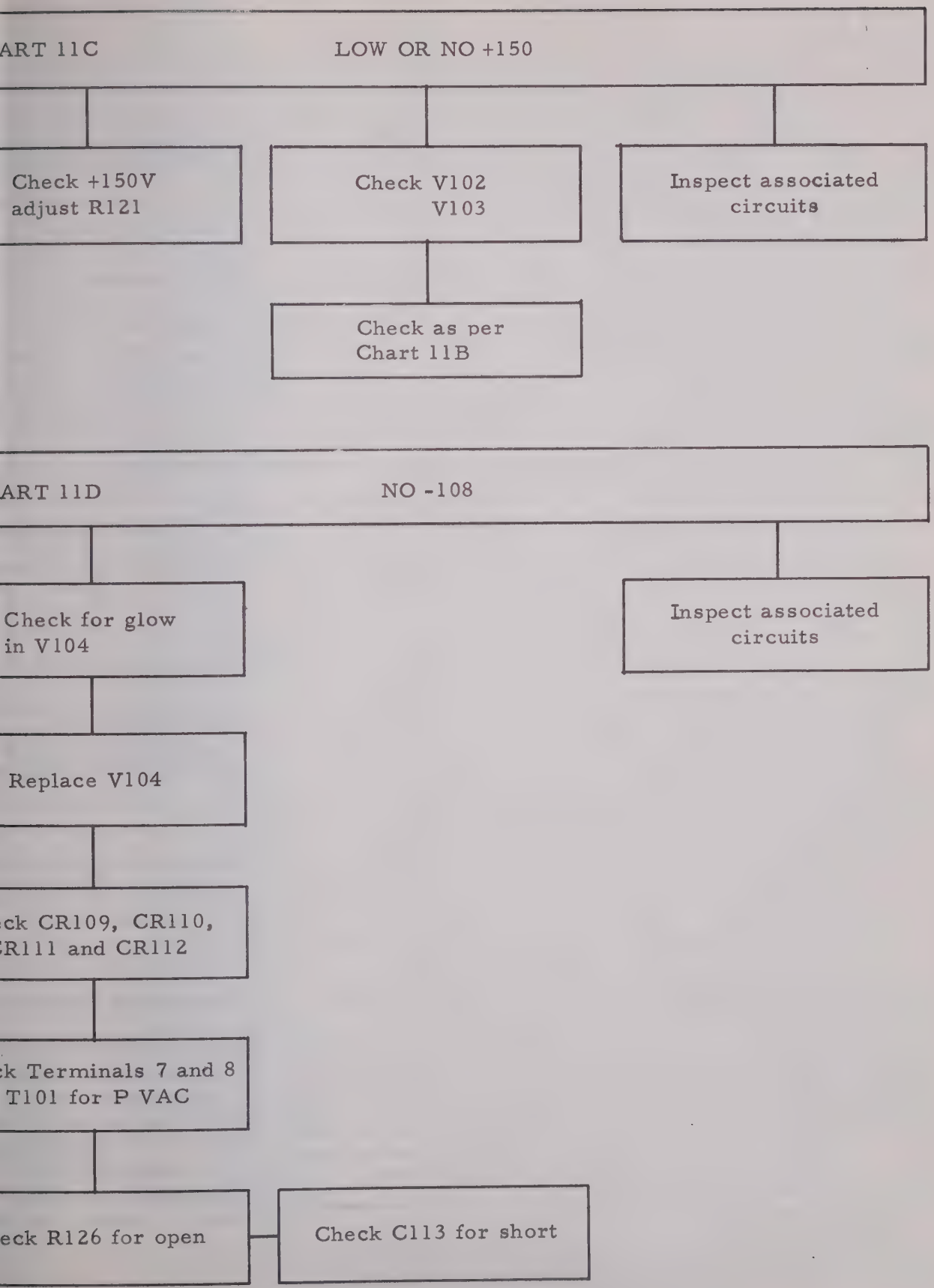


CHART 10
SWEEP AND VIDEO PRESENT BUT NO MARKERS
Check that timer board is properly in place
Check that marker signal is present waveform 41
Check output (waveform 30) of marker flip-flop on timer board
Check V305
Check DC Voltage chart
CHART 11A
NO +400 VOLTS
R102 open
Check for short in associated circuit
Check C103 for short
Check CR101
CR102
CR103
CR104
Check terminals 3 and
T101 for 225V AC
CHART 11B
LOW OR NO +300 VOLTS
Check +300V adjust R113
Check V102, V101 and V103
Check associated circuit components


ART 11C
LOW OR NO +150
Check +150V adjust R121
Check V102 V103
Inspect associated circuits
Check as per Chart 11B
ART 11D
NO -108
Check for glow in V104
Inspect associated circuits
Replace V104
ck CR109, CR110, R111 and CR112
k Terminals 7 and 8 T101 for P VAC
eck R126 for open
Check C113 for short

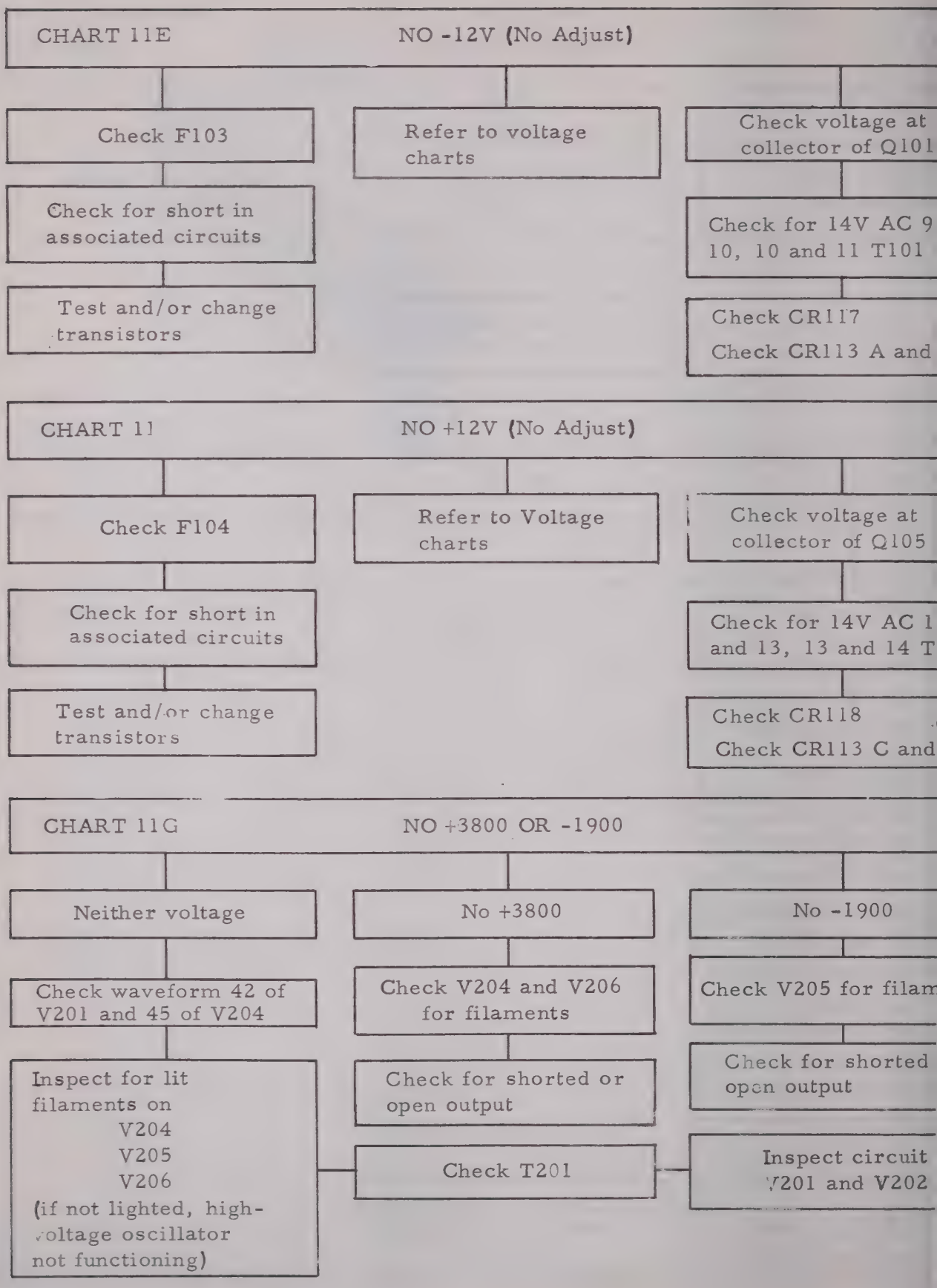


CHART 11E
NO -12V (No Adjust)
Check F103
Check for short in associated circuits
Test and/or change transistors
Refer to voltage charts
Check voltage at collector of Q101
Check for 14V AC 9
10, 10 and 11 T101
Check CR117
Check CR113 A and
CHART 11
NO +12V (No Adjust)
Check F104
Check for short in associated circuits
Test and/or change transistors
Refer to Voltage charts
Check voltage at collector of Q105
Check for 14V AC 1
and 13, 13 and 14 T
Check CR118
Check CR113 C and
CHART 11G
NO +3800 OR -1900
Neither voltage
Check waveform 42 of V201 and 45 of V204
Inspect for lit filaments on
V204
V205
V206
(if not lighted, high-voltage oscillator not functioning)
No +3800
Check V204 and V206 for filaments
Check for shorted or open output
Check T201
No -1900
Check V205 for filam
Check for shorted open output
Inspect circuit V201 and V202

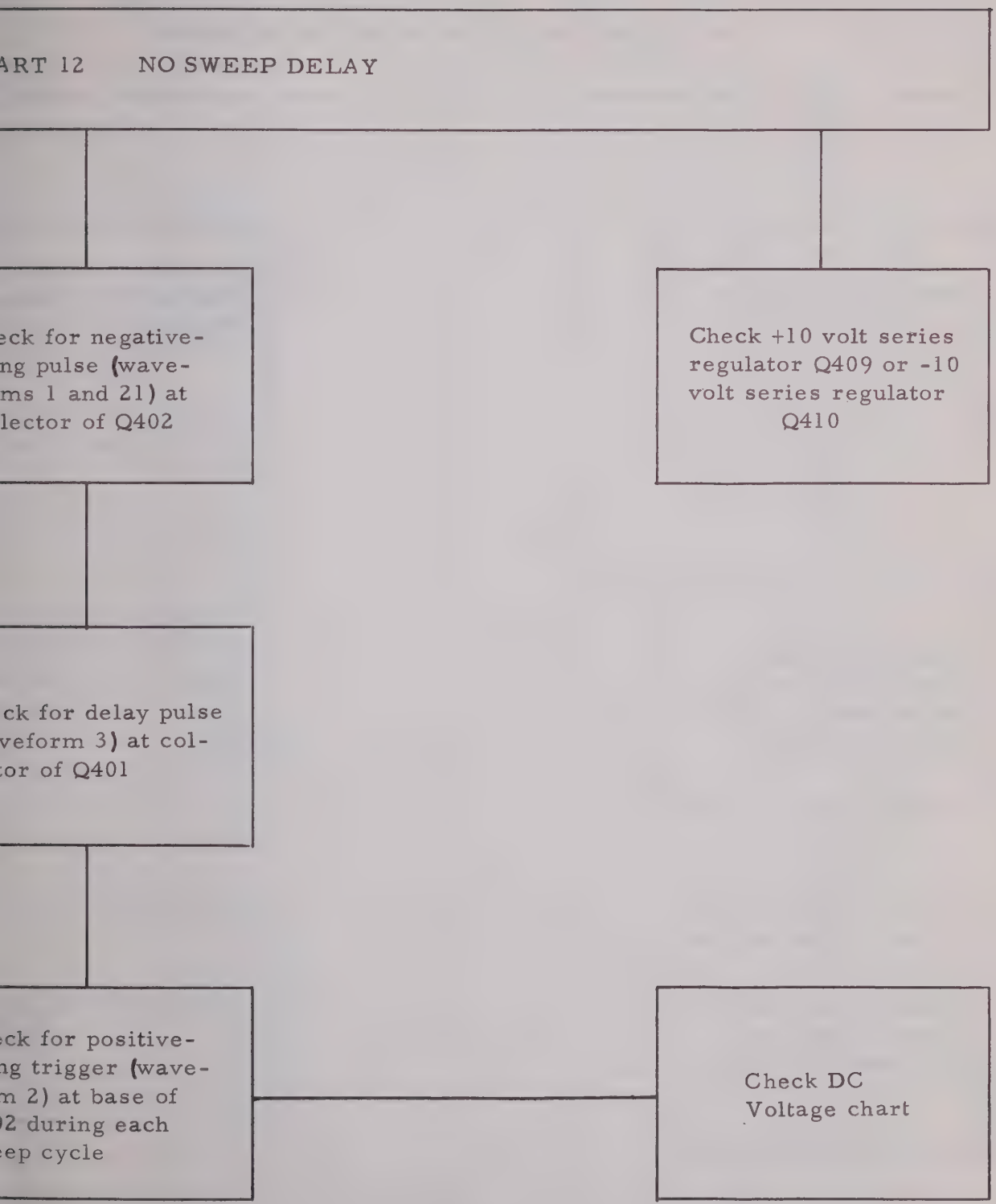

ART 12 NO SWEEP DELAY
eck for negative-
ng pulse (wave-
ms 1 and 21) at
lector of Q402
Check +10 volt series
regulator Q409 or -10
volt series regulator
Q410
ck for delay pulse
veform 3) at col-
or of Q401
ck for positive-
ng trigger (wave-
m 2) at base of
02 during each
ep cycle
Check DC
Voltage chart

CHART 13 NO OUTPUT MARKERS FROM TIMER BOARD

Check outputs (waveforms 18 and 19) of marker generator Q418 and Q419

Check delay regenerator Q415 and Q416 (waveforms 16, 17, 26, 27, 28 and 29)

Check display divider circuitry Q411 and Q412 (waveforms 12, 13, 15, 24 and 25)

Check -10 volt ser regulator Q409 or - volt series regula Q410

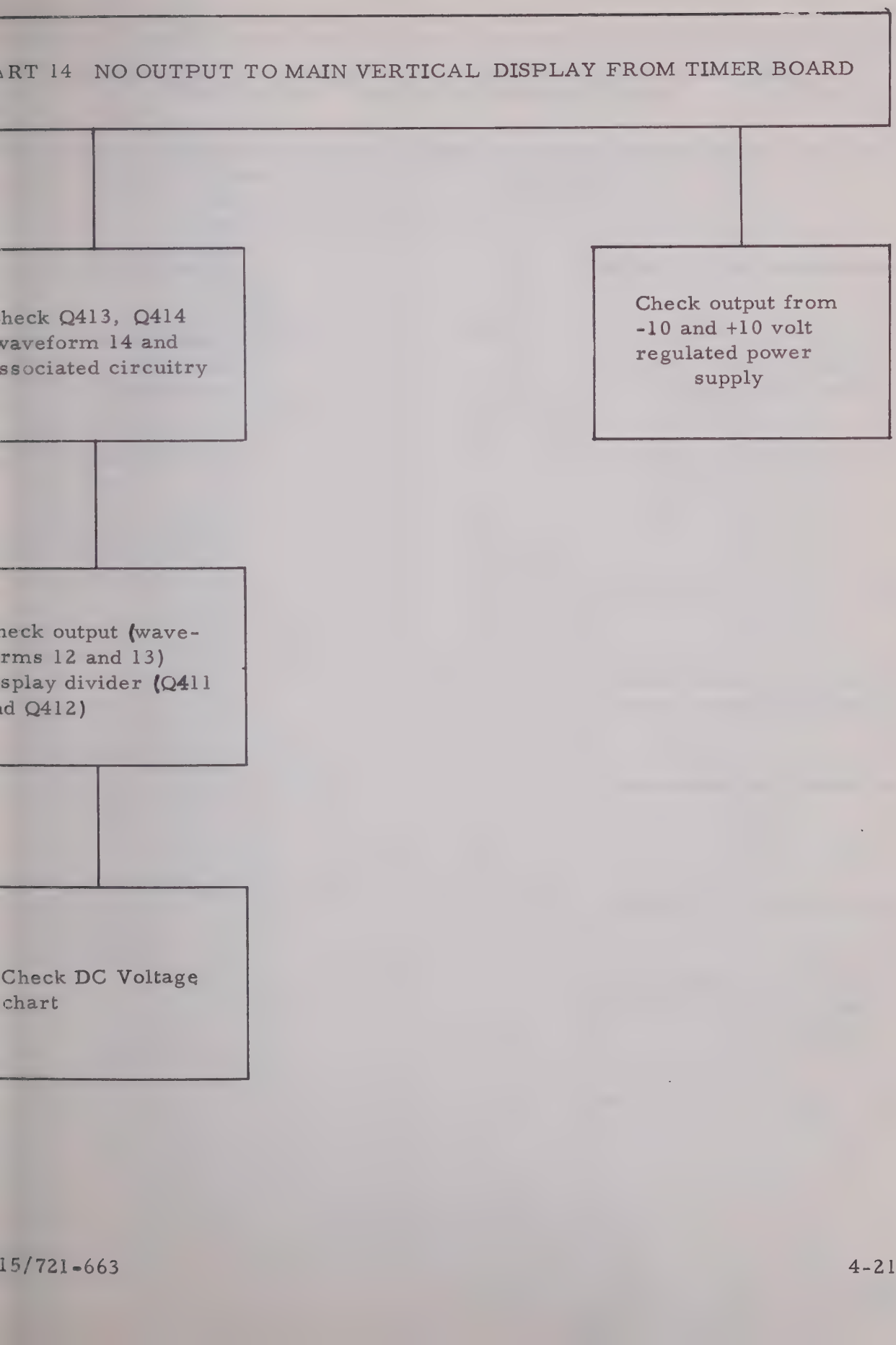

ART 14 NO OUTPUT TO MAIN VERTICAL DISPLAY FROM TIMER BOARD
heck Q413, Q414
vaveform 14 and
ssociated circuitry
Check output from
-10 and +10 volt
regulated power
supply
neck output (wave-
rms 12 and 13)
splay divider (Q411
d Q412)
Check DC Voltage
chart

CHART 15 NO UNBLANK PULSE FROM TIMER BOARD

Check output (waveforms 6 and 8) of unblank buffer Q403

Check output (waveform 4) of sweep delay circuit

Check output (waveform 11) of rate space one shot Q407

Check output of negat and positive 12 volt power supply

DEFLECTION AMPLIFIER BOARD 50C770 DC VOLTAGE CHART

NOTES

1. Use Simpson Model 360 or equivalent.
2. Voltage measurements are with respect to the DC power supply ground.

TEST POINT	VOLTAGE	TEST POINT	VOLTAGE
V301, Pin 1	+300	V303, Pin 6	0
V301, Pin 2	--0.3	V303, Pin 7	+212
V301, Pin 3	+130	V303, Pin 8	+150
V301, Pin 4	0	V303, Pin 9	+3.3
V301, Pin 5	0		
V301, Pin 6	+105	V304, Pin 1	+3.3
V301, Pin 7	+3.2	V304, Pin 2	+2.76
V301, Pin 8	+110	V304, Pin 3	+3.3
V301, Pin 9	+105	V304, Pin 4	0
		V304, Pin 5	0
V302, Pin 1	+257	V304, Pin 6	0
V302, Pin 2	+60	V304, Pin 7	+160
V302, Pin 3	+67	V304, Pin 8	+150
V302, Pin 4	0	V304, Pin 9	+3.3
V302, Pin 5	0		
V302, Pin 6	+110	V305, Pin 1	+300
V302, Pin 7	+65	V305, Pin 2	+145
V302, Pin 8	+67	V305, Pin 3	+150
		V305, Pin 4	0
V303, Pin 1	+3.3	V305, Pin 5	0
V303, Pin 2	+0.4	V305, Pin 6	+295
V303, Pin 3	+3.3	V305, Pin 7	+145
V303, Pin 4	0	V305, Pin 8	+153
V303, Pin 5	0	V305, Pin 9	0

HIGH VOLTAGE BOARD 50C771 DC VOLTAGE CHART

NOTES

1. Use Simpson Model 360 or equivalent
2. Voltage measurements are with respect to the DC power supply ground.

TEST POINT	VOLTAGE	TEST POINT	VOLTAGE
V201, Pin 1	-38	V202, Pin 7	-3.9
V201, Pin 2	0	V202, Pin 8	0
V201, Pin 3	0	V202, Pin 9	0
V201, Pin 4	0		
V201, Pin 5	+320	V203, Pin 1	3300
V201, Pin 6	+100	V203, Pin 2	55
V201, Pin 7	-38	V203, Pin 3	63
		V203, Pin 4	0
V202, Pin 1	-3.9	V203, Pin 5	0
V202, Pin 2	-111	V203, Pin 6	55
V202, Pin 3	-104	V203, Pin 7	-1.4
V202, Pin 4	0	V203, Pin 8	0
V202, Pin 5	0	V203, Pin 9	0
V202, Pin 6	+98		

POWER SUPPLY DC VOLTAGE CHART

NOTES

1. Use Simpson Model 360 or equivalent.
2. Voltage measurements are with respect to the DC power supply ground.

TEST POINT.	VOLTAGE	TEST POINT	VOLTAGE
V101, Pin 1	+147	V104, Pin 1, 5	0
V101, Pin 2	+150	V104, Pin 2, 7	-108
V101, Pin 3	+150		
V101, Pin 4	+150		
V101, Pin 5	+270	C113 Negative element	-150
V101, Pin 6	+240		
V101, Pin 7	+150	C114 Negative element	-17.6
V102, Pin 1	+116		
V102, Pin 2	+274		
V102, Pin 3	+150	Q104 Emitter and	
V102, Pin 4	+270	Q103 Emitter	-8.8
V102, Pin 5	+395		
V102, Pin 6	+300	C117 Negative element	-4
V102, Pin 7	+150		
V102, Pin 8	+150	C117 Positive element	+12
V103, Pin 1	-4.4		
V103, Pin 2	0	Q108 Emitter and	
V103, Pin 3	0	Q107 Emitter	+3.4
V103, Pin 4	0		
V103, Pin 5	+116		
V103, Pin 6	+142		
V103, Pin 7	0		

TIMER BOARD 50D352 DC VOLTAGE CHART

NOTES

1. Use Simpson Model 360 or equivalent.
2. Voltage measurements are with respect to the DC power supply ground.
3. Rotate RATE C. W.
4. Set PRESET-DIAL SWITCH TO DIAL position.
5. Rotate MATERIAL dial control to ALUMINUM.
6. Set INCHES switch to position 5.
7. Set INCHES MULTIPLIER switch to x .1
8. Rotate SWEEP DELAY controls full C. W.
9. Remove transistor Q408.

TEST POINT	VOLTAGE
Q401-E	0
Q401-B	+0.26
Q401-C	+0.05
Q402-E	+10.35
Q402-B	+10.1
Q402-C	+10.25
Q403-E	0
Q403-B	-2.44
Q403-C	+9.7
Q404-E	+9.2
Q404-B	+8.9
Q404-C	-0.54
Q405-E	-0.57
Q405-B	-0.59
Q405-C	+12
Q406-E	-0.67
Q406-B	-0.80
Q406-C	+9.7
CR408 and R426 junction	+0.98
Q407-E	+11.6
Q407-B	+11.5
Q407-C	-1.16
R434 and C416 junction	+6.4
R435 and C416 junction	+0.63
Q408-E	0
Q408-B	+0.58
Q408-C	+12

TEST POINT	VOLTAGE
Q409-E	+10.4
Q409-B	+10.6
Q409-C	+12
Q410-E	+10.4
Q410-B	-10.6
Q410-C	-12

NOTE

Short resistor R449 with a jum
before making the following vo
age measurements.

Q411-E	+11.5
Q411-B	+11.1
Q411-C	+11.4
Q412-E	+11.5
Q412-B	+12
Q412-C	-9.3
Q414-E and -B	+6.2 to -0. varies with setting of R
Q414-C	+0.56
Pin 7, J501	-7.1 to -4. varies with setting of R
Pin 18, J501	-2.2 to -4. varies with setting of R
L401 and C428 junction	0

TIMER BOARD 50D352 DC VOLTAGE CHART (cont)

TEST POINT	VOLTAGE
Q415-E	0
Q415-B	-0.26
Q415-C	-0.02
Q416-E	-11.2
Q416-B	-11.0
Q417-E	0
Q417-B	-0.36
Q417-C	-0.1

NOTE

Remove shorting jumper from resistor R449 and connect shorting jumper across resistor R448 for the following voltage measurements.

Q411-E	11.5
Q411-B	12.0
Q411-C	-10.0
Q412-E	+11.7
Q412-B	+12.4
Q412-C	+11.7
Q414-E and -B	+0.16 to +6.2, varies with setting of R409
Q414-C	+0.16
Pin 7, J501	+2.2 to +6.3, varies with setting of R511
Pin 18, J501	+2.2
L401 and C428 junction	0
Q415-E	0
Q415-B	+0.62
Q415-C	-11.7
Q416-E	-11.5
Q416-B	-11.2
Q416-C	+10.6
Q417-E	0
Q417-B	+7.0
Q417-C	+11.8

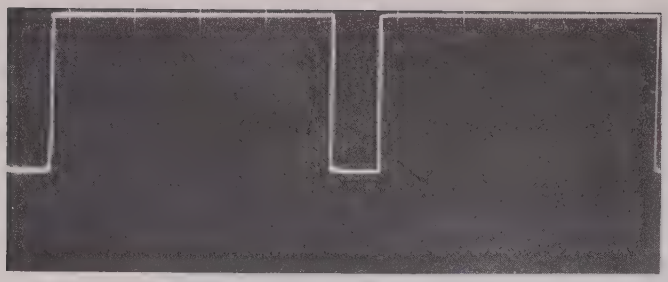
NOTE

The following measurements are made with resistor R448 and the base of transistor Q419 grounded.

Q418-E	0
Q418-B	-0.4
Q418-C	-0.11
Pin 9, J501	-0.58 to -10.3, varies with setting of R513
CR425 Anode	-0.62
R463 and R464 junction	-3.48

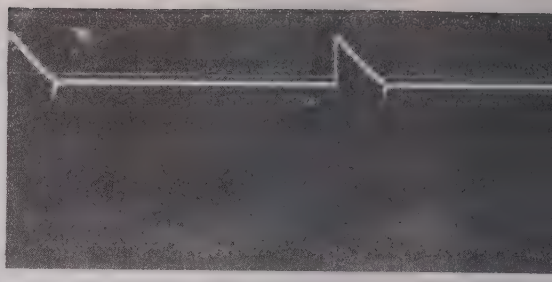
NOTE

Collector voltages of transistor Q418 and Q419 alternately switch from -0.2 to -4.2 as each base is shorted to ground potential.



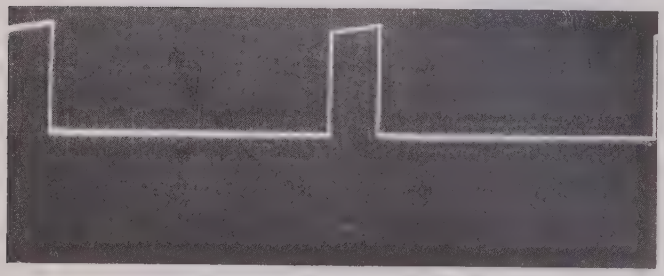
1

TEST POINT: Q402 collector
SYNC: T.P.B + EXT.
TIME/CM: 0.2 millisec
VOLTS/CM: 5V



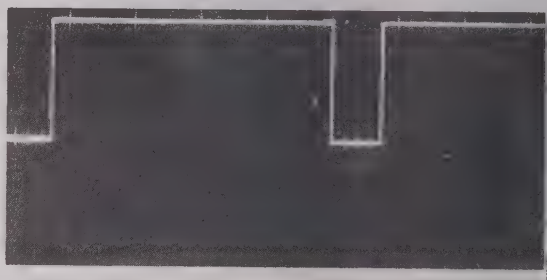
2

TEST POINT: CR403 + Pin
SYNC: T.P.B + EXT.
TIME/CM: 0.2 millisec
VOLTS/CM: 10V



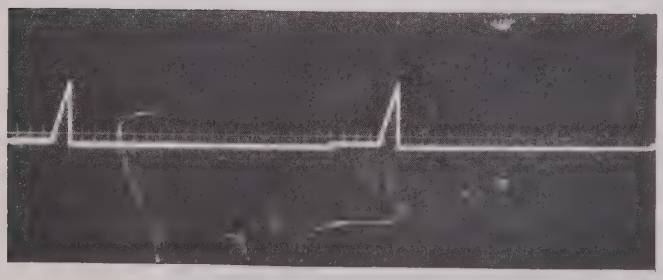
3

TEST POINT: Q401 collector
SYNC: T.P.B + EXT.
TIME/CM: 0.2 millisec
VOLTS/CM: 5V



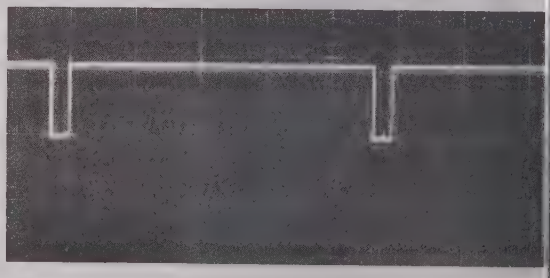
4

TEST POINT: CR404, CR40
SYNC: T.P.B + EXT
TIME/CM: 0.2 millisec
VOLTS/CM: 5V



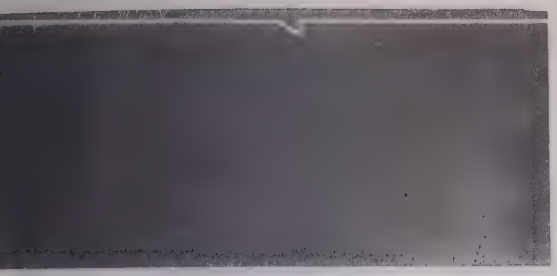
5

TEST POINT: Q406 emitter
SYNC: T.P.B + EXT.
TIME/CM: 0.2 millisec
VOLTS/CM: 5V



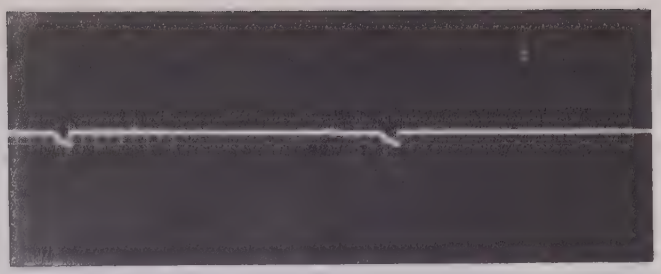
6

TEST POINT: Q403 collectc
SYNC: T.P.B + EXT.
TIME/CM: 0.2 millisec
VOLTS/CM: 10V



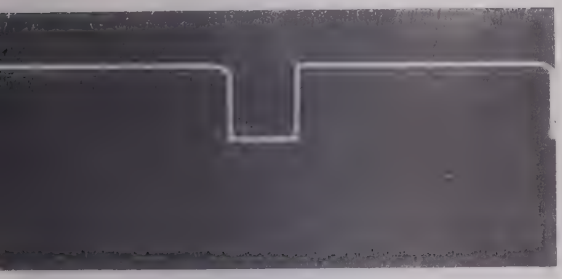
7

TEST POINT: Q406, collect
SYNC: T. P. B + EXT.
TIME/CM: 0.2 millisec
VOLTS/CM: 10V



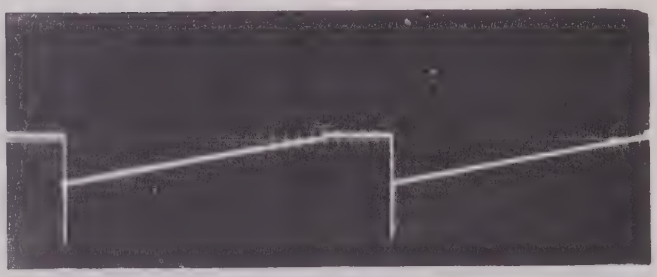
8

TEST POINT: CR413 cathode
SYNC: T. P. B + EXT.
TIME/CM: 0.2 millisec
VOLTS/CM: 1V



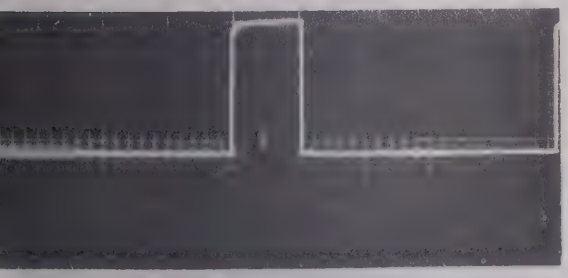
9

TEST POINT: Q408 collector
SYNC: T. P. B + EXT.
TIME/CM: 0.2 millisec
VOLTS/CM: 10V



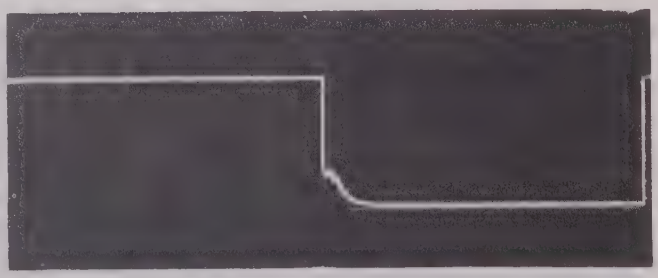
10

TEST POINT: Q408 base
SYNC: T. P. B + EXT.
TIME/CM: 0.2 millisec
VOLTS/CM: 2V



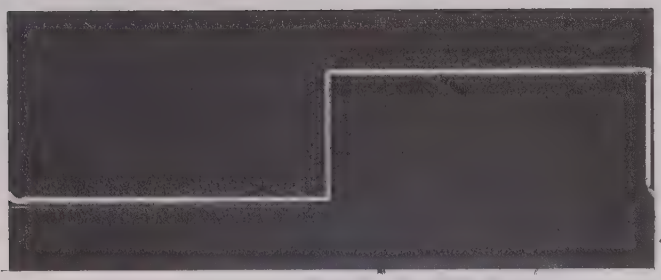
11

TEST POINT: T. P. A
SYNC: T. P. B + EXT.
TIME/CM: 0.2 millisec
VOLTS/CM: 5V



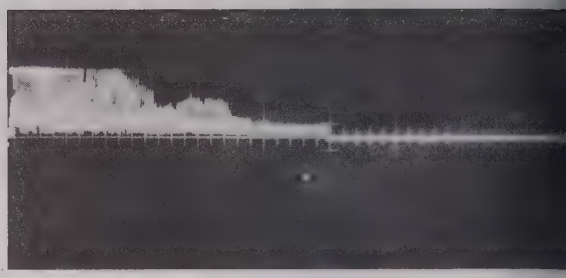
12

TEST POINT: Q411 collector
SYNC: T. P. B + EXT.
TIME/CM: 0.2 millisec
VOLTS/CM: 10V



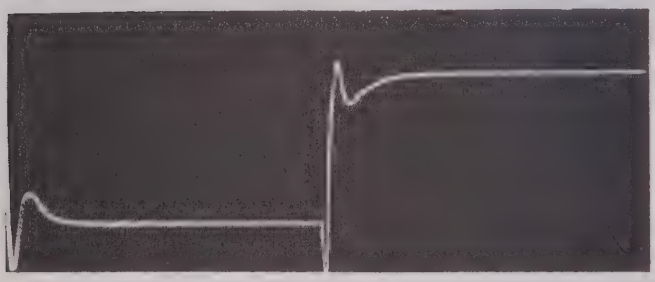
13

TEST POINT: Q412 collector
SYNC: T. P. B ± EXT.
TIME/CM: 0.2 millisec
VOLTS/CM: 10V



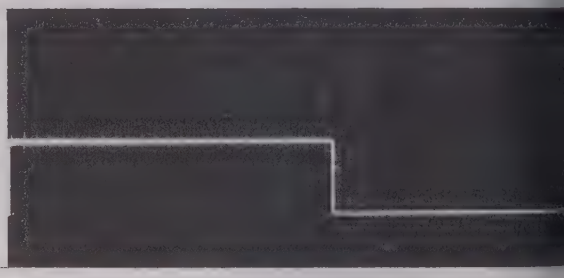
14

TEST POINT: Q414 collector
SYNC: T. P. B + EXT.
TIME/CM: 0.2 millisec
VOLTS/CM: 2V



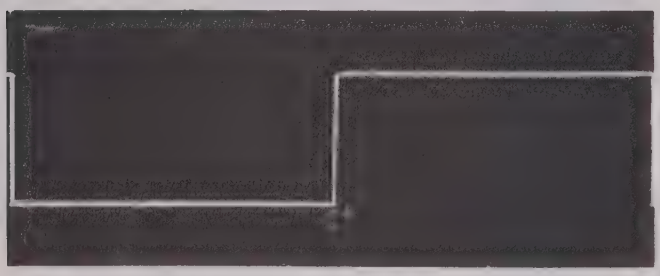
15

TEST POINT: Pin 18
SYNC: T. P. B + EXT.
TIME/CM: 0.2 millisec
VOLTS/CM: 2V



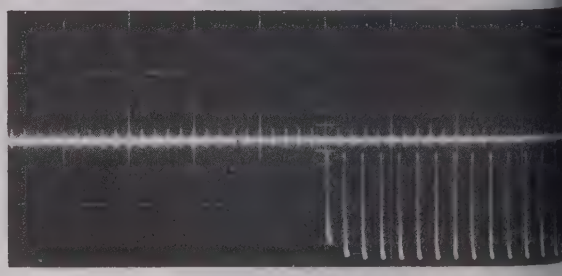
16

TEST POINT: Q415 collector
SYNC: T. P. B + EXT.
TIME/CM: 0.2 millisec
VOLTS/CM: 10V



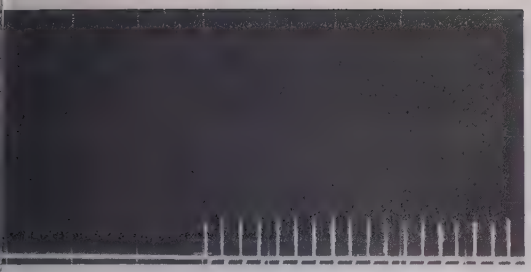
17

TEST POINT: Q416 collector
SYNC: T. P. B + EXT.
TIME/CM: 0.2 millisec
VOLTS/CM: 10V



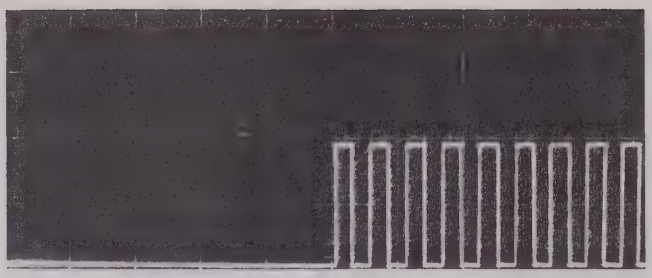
18

TEST POINT: Q418 collector
SYNC: T. P. B. + EXT.
TIME/CM: 0.2 millisec
VOLTS/CM: 5V



19

TEST POINT: L402, R462
SYNC: T. P. B + EXT.
TIME/CM: 0.2 millisec
VOLTS/CM: 1V



20

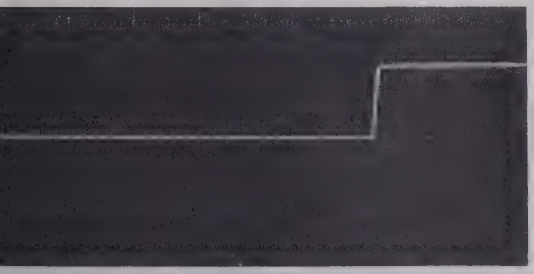
TEST POINT: Q421 collector
SYNC: T. P. B + EXT.
TIME/CM: 0.2 millisec
VOLTS/CM: 2V

21

TEST POINT: Q402 collector
SYNC: T. P. B + EXT.
TIME/CM: 10 microsec.
VOLTS/CM 5V

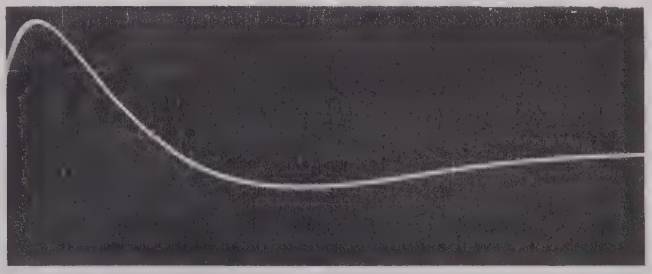
22

TEST POINT: Q406 emitter
SYNC: T. P. B + EXT.
TIME/CM: 10 microsec
VOLTS/CM: 2V



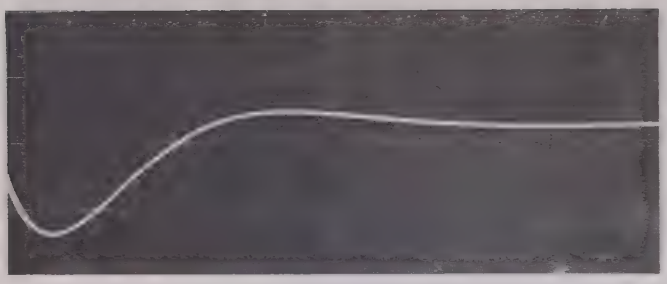
23

TEST POINT: Q403 collector
SYNC: T. P. B + EXT.
TIME/CM: 10 microsec
VOLTS/CM: 10V



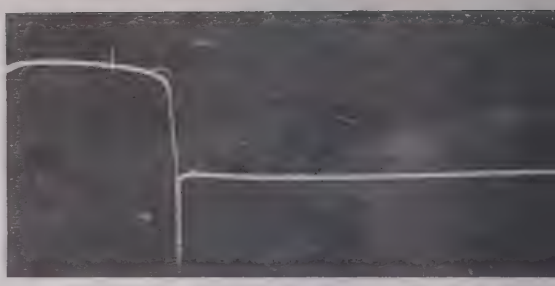
24

TEST POINT: Pin 18
SYNC: T. P. B + EXT.
TIME/CM: 10 microsec
VOLTS/CM: 5V



25

TEST POINT: Pin 18
SYNC: T. P. B - EXT.
TIME/CM: 10 microsec
VOLTS/CM: 5V

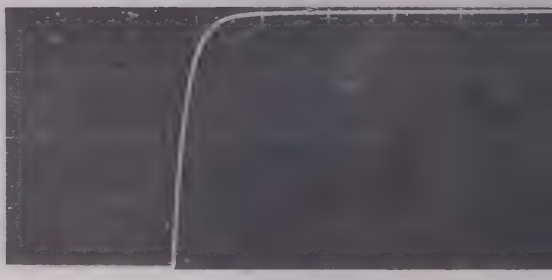


26

TEST POINT: Q415 base
SYNC: T. P. B + EXT.
TIME/CM: 10 microsec
VOLTS/CM: 0.5V

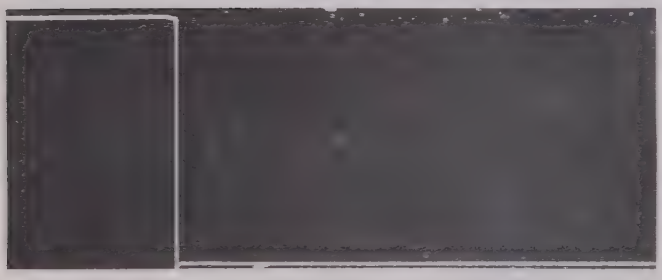
27

TEST POINT: Q415 base
SYNC: T. P. B - EXT.
TIME/CM: 10 microsec
VOLTS/CM: 0.5V



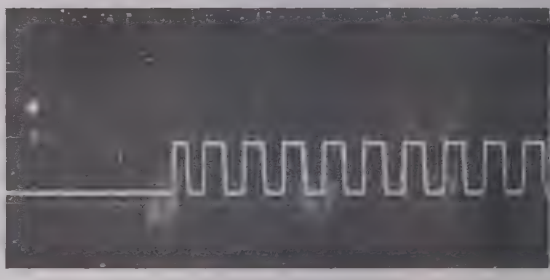
28

TEST POINT: Q416 collector
SYNC: T. P. B - EXT.
TIME/CM: 10 microsec
VOLTS/CM: 5V



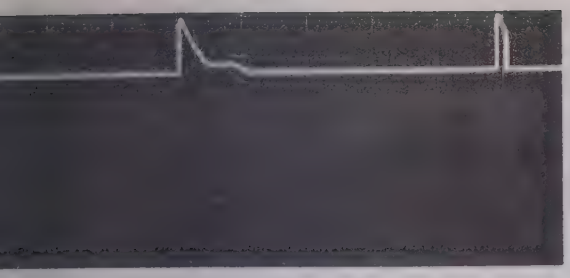
29

TEST POINT: Q416 collector
SYNC: T. P. B + EXT.
TIME/CM: 10 microsec
VOLTS/CM: 5V



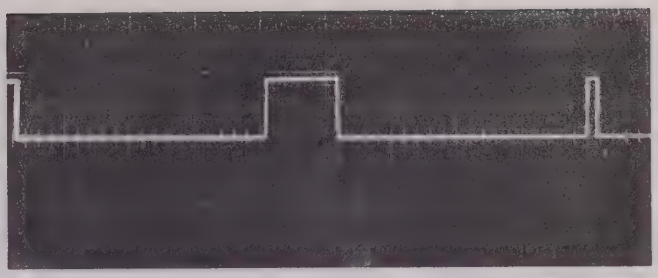
30

TEST POINT: Q421 collector
SYNC: T. P. B - EXT.
TIME/CM: 10 microsec
VOLTS/CM: 5V



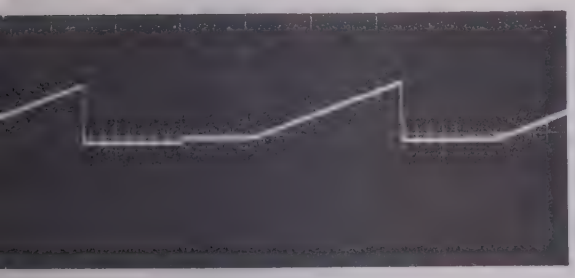
31

TEST POINT: Q402 base
SYNC: T.P.B + EXT.
TIME/CM: 0.5 millisec
VOLTS/CM: 10V



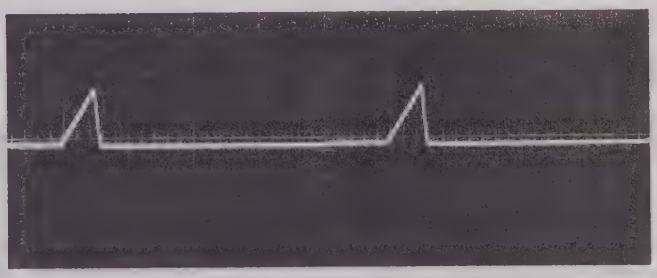
32

TEST POINT: Q401 collector
SYNC: T.P.B + EXT.
TIME/CM: 0.5 millisec
VOLTS/CM: 10V



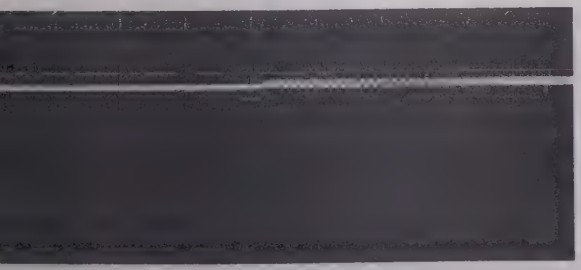
33

TEST POINT: Q406, emitter
SYNC: T.P. B + EXT.
TIME/CM: 0.5 millisec
VOLTS/CM: 5V



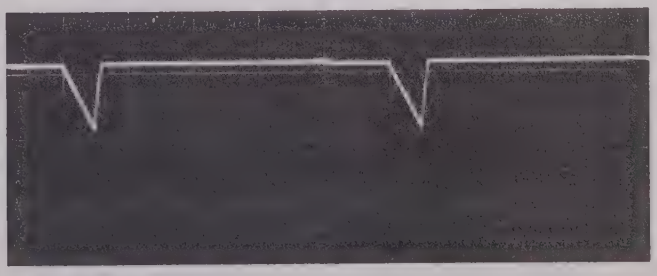
34

TEST POINT: V301, Pin 2
SYNC: T.P.B. + EXT.
TIME/CM: 0.2 millisec
VOLTS/CM: 5V Center line is 0 VDC



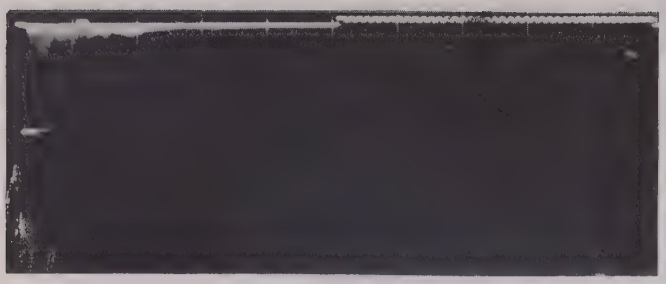
35

ST POINT: V303, Pin 8
NC: T.P.B + EXT.
ME/CM: 0.2 millisec
OLTS/CM: 50V Bottom line is 0 VDC



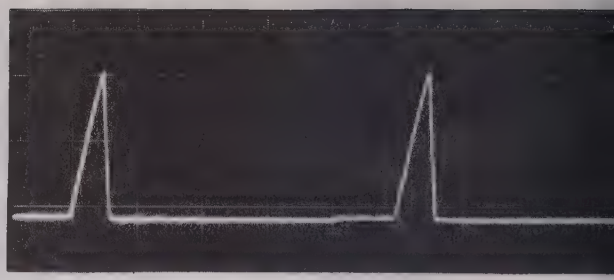
36

TEST POINT: V302, Pin 7
SYNC: T.P.B + EXT.
TIME/CM: 0.2 millisec
VOLTS/CM: 20V Bottom line is 0 VDC



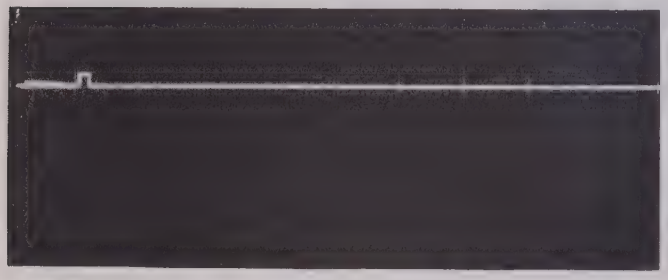
37

TEST POINT: V303, Pin 7
SYNC: T. P. B + EXT.
TIME/CM: 0. 2 millisec
VOLTS/CM: 50V Bottom line is 0 VDC



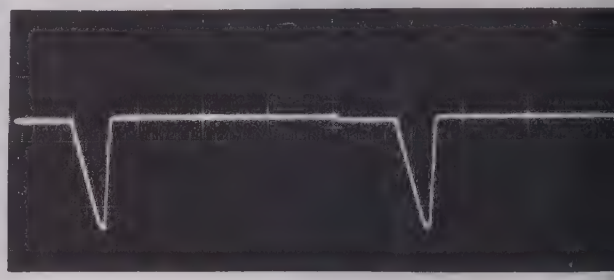
38

TEST POINT: V302, Pin 6
SYNC: T. P. B + EXT.
TIME/CM: 0. 2 millisec
VOLTS/CM: 100V Bottom line is 0 VD



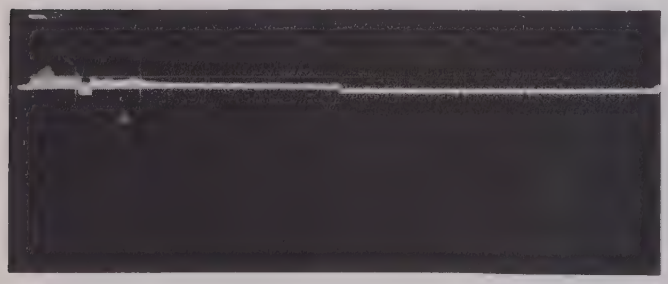
39

TEST POINT: V304, Pin 8
SYNC: T. P. B + EXT.
TIME/CM: 0. 2 millisec.
VOLTS/CM: 50V Bottom line is 0 VDC



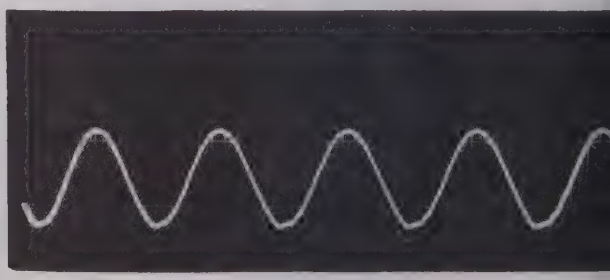
40

TEST POINT: V302, Pin 1
A SYNC: T. P. B + EXT.
TIME/CM: 0. 2 millisec
VOLTS/CM: 100V Bottom line is 0 VD



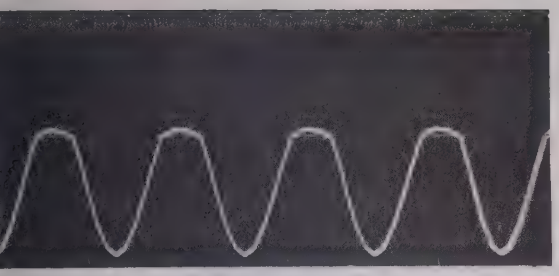
41

TEST POINT: V304, Pin 7
SYNC: T. P. B + EXT.
TIME/CM: 0. 2 millisec
VOLTS/CM: 50V Bottom line is 0 VDC



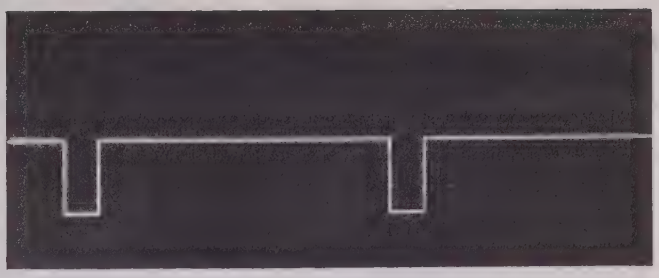
42

TEST POINT: V201, Pin 5
SYNC: + EXT.
TIME/CM: 10 microsec
VOLTS/CM: 20V Bottom line is 0 VD



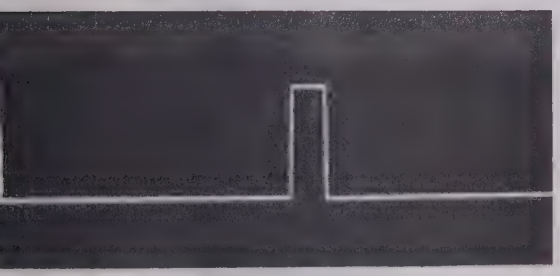
43

T POINT: V301, Pin 7
C: Junction R202, R203
E/CM: 10 microsec
TS/CM: 50V Center line is 0 VDC



44

TEST POINT: V203, Pin 7
SYNC: + EXT.
TIME/CM: 0.2 millisec
VOLTS/CM: 10V Center line is 0 VDC



45

T POINT: V204, Pin 3
C: + EXT.
E/CM: 0.2 millisec
TS/CM 50V Center line is 0 VDC

POWER SUPPLY
Reference Schematic 50D358 (UM715)
Reference Schematic 50D348 (UM721)

Schematic Symbol No.	Sperry Part No.	Description
C101	DQJ003A19	Capacitor .01uf 500v
C102	Same as C101	
C103	DQL004A10	Capacitor 125uf 300v
C104	Sprague	Capacitor .1uf 500v 5HK-P10
C105	Sprague	Capacitor 3 x 20uf 450v TLV3780
C108	Same as C103	
C110	Same as C104	
C111	Same as C101	
C112	Same as C104	
C113	Same as C103	
C114	DQL004A11	Capacitor 1500uf 50v
C116	DQL001A40	Capacitor 40uf 150v (for UM715)
C116	DQL004A09	Capacitor 40uf 250v (for UM721)
C117	Same as C114	
C308	Same as C104	
CR101	Solitron Devices, Inc.	Diode CER-500
CR102 thru CR112	Same as CR101	
CR113	Solitron Devices, Inc.	Diode 2SPF-100
F103	CJA004C08	Fuse 2 amps 250v
F104	Same as F103	
J101	CQC017S01	Receptacle
J201	50A2480	Connector
J301	50A2481	Connector
Q101	2N399-9	Transistor
Q105	Same as Q101	
R102	DPA005A01	Resistor 10 ohms 1/2W ± 10%
R103	DPA006D15	Resistor 39K 1W ± 5%
R104	DPA006D21	Resistor 68K 1W ±5%
R105	DPA005B09	Resistor 470 ohms 1/2W ± 10%
R106	DPA006D11	Resistor 27K 1W ± 5%
R107	Same as R105	
R108	DPA005F03	Resistor 1.5 Meg 1/2W ± 10%
R109	Sprague	Resistor 1.8K 5W 452E1825
R110	DPA007C01	Resistor 1K 1W ± 10%
R111	DPB003A33	Resistor 900 ohms 10W ± 5%
R112	DPA006D24	Resistor 91K 1W ± 5%
R113	50A3129	Potentiometer 50K
R114	Same as R112	
R115	Same as R102	
R116	Same as R102	
R117	Same as R103	
R118	Same as R106	
R119	Same as R105	
R120	DPA004D24	Resistor 91K 1/2W ± 5%
R121	Same as R113	
R122	DPA004D19	Resistor 56K 1/2W ± 5%
R123	50A3130	Potentiometer 1 Meg
R124	DPA005F01	Resistor 1 Meg 1/2W ± 10%
R125	CNA002A29	Resistor 600 ohms 5W ± 5%
R126	Same as R102	
R137	DPA007B01	Resistor 100 ohms 1W ± 10%
R352	DPA004C01	Resistor 1K 1/2W ± 5%
T101	50C327	Transformer
	Bendix	Transistor Socket 210-6500
	COA00A04	Terminal Strip
	DTB010A01	Tube Socket
	DTB013A02	Tube Socket
Tektronix	Tektronix	Terminal Strip 124-091
	Tektronix	Terminal Strip 124-095

L. V. REGULATOR BOARD ASSEMBLY
Reference Schematic 50D358

Schematic Symbol No.	Sperry Part No.	Description
C115	Sprague	Capacitor 20uf 25v TE-1206
C118	Same as C115	
C119	Sprague	Capacitor 10uf 25v TE-1204
C120	Same as C119	
C121	Same as C119	
C127	Same as C119	
CR117	Sarkes Tarzian	Zener Diode VR8.5 ± 10%
CR118	Same as CR117	
Q102	2N414	Transistor
Q103	Same as Q102	
Q104	Same as Q102	
Q106	Same as Q102	
Q107	Same as Q102	
Q108	Same as Q102	
R127	DPA006D03	Resistor 12K 1W 5%
R128	DPA006C15	Resistor 3.9K 1W 5%
R129	DPA004D05	Resistor 15K 1/2W 5%
R130	DPA004B10	Resistor 240 ohms 1/2W 5%
R131	DPA004B23	Resistor 820 ohms 1/2W 5%
R132	DPA004C01	Resistor 1K 1/2W 5%
R133	DPA004B13	Resistor 330 ohms 1/2W 5%
R134	DPA006B11	Resistor 270 ohms 1W 5%
R135	Bourns	Potentiometer 275-1-502
R136	DPA004A13	Resistor 33 ohms 1/2W 5%
R138	Same as R129	
R139	Same as R130	
R140	Same as R131	
R141	Same as R132	
R142	Same as R133	
R143	Same as R134	
R144	Same as R135	
R145	Same as R136	
R147	DPA004C17	Resistor 4.7K 1/2W 5%
R148	Same as R147	
	ELCO	Socket 3303

H. V. POWER SUPPLY ASSEMBLY
Reference Schematic 50D358

Schematic Symbol No.	Sperry Part No.	Description
C201	DQJ003A13	Capacitor . 001uf 500v
C202	Sprague	Capacitor . 0068uf 3000v 184P682030
C203	DQG001C01	Capacitor . 01uf 600v
C204	DQG005B08	Capacitor . 001uf 600v ± 20%
C206	Sprague	Capacitor . 015uf 3000v 184P153030
C207	Same as C202	
C208	Same as C206	
C209	Sprague	Capacitor . 0068uf 5000v 184P682050
C210	Sprague	Capacitor . 1uf 500v 5HKP10
C211	Sprague	Capacitor 500uf 6000v 60GA-T50
CR201	1N485	Diode
R201	DPA008D17	Resistor
R202	DPA004C13	Resistor
R203	DPA004D11	Resistor
R204	DPA008E17	Resistor
R205	DPA005F05	Resistor
R206	Same as R205	
R207	Same as R205	
R208	DPA005D01	Resistor
R209	DPA004F05	Resistor
R210	DPA009D01	Resistor
R211	DPA004F01	Resistor
R212	DPA008D07	Resistor
R214	DPA005F05	Resistor
T201	50B714	H. V. Transformer
V204	5642	Tube
V205	Same as V204	
V206	Same as V204	
	ELCO	Tube Socket 623BC
	ELCO	Tube Socket 622PHSP
	Grayhill	Sleeve 31B-2
	Grayhill	Sleeve 31B-3
	Grayhill	Sleeve 31B-7
	CSE001A09	Sleeve

DEFLECTION AMPLIFIER COMPONENT ASSEMBLY
Reference Schematic

Schematic Symbol No.	Sperry Part No.	Description
C302	DQB005C36	Capacitor 240uuf 500v 10%
C305	DQG002A07	Capacitor 1.0uf 200v
C306	Sprague	Capacitor .1uf 25v 5C7
C309	DQB005A02	Capacitor 2uuf 500v 2%
C310	DQB005A02	Capacitor 2uuf 500v 2%
R301	DPA005F01	Resistor 1 Meg 1/2W 5%
R302	DPA007B12	Resistor 820 ohms 1W 10%
R303	DPA004A24	Resistor 91 ohms 1/2W 5%
R304	DPA007D03	Resistor 15K 1W 10%
R305	DPA006D06	Resistor 16K 1W 5%
R306	Same as R303	
R307	Same as R303	
R310	DPA004C20	Resistor 6.2K 1/2W ±5%
R311	DPA004C15	Resistor 3.9K 1/2W ±5%
R312	DPA009D09	Resistor 47K 2W 10%
R313	Same as R312	
R314	Same as R303	
R315	DPA009D04	Resistor 18K 2W 10%
R317	DPA005D06	Resistor 27K 1/2W 10%
R319	Same as R317	
R320	DPA004D17	Resistor 47K 1/2W 5%
R321	DPA004C01	Resistor 1K 1/2W 5%
R322	DPA008B16	Resistor 430 ohms 2W 5%
R323	DPA004A03	Resistor 12 ohms 1/2W 5%
R324	DPA004E01	Resistor 100K ohms 1/2W 5%
R325	DPA006D01	Resistor 10K 1W 5%
R329	Same as R323	
R330	DPA004A23	Resistor 82 ohms 1/2W 5%
R331	Same as R324	
R332	Same as R324	
R333	Same as R330	
R334	DPA004D01	Resistor 10K 1/2W 5%
R335	DPA008B18	Resistor 510 ohms 2W 5%
R336	Same as R324	
R337	Same as R324	
R338	Same as R334	
R339	Sprague	Resistor 2.5K 10W 457E2525_
R345	Chic. Tel.	Potentiometer 150 ohms Type 110
R346	Same as R322	
R347	Same as R339	
R348	DPA004C17	Resistor 4.7K 1/2W 5%
R349	Same as R325	
R350	Same as R315	
R351	Chic. Tel	Potentiometer 2.5K Type 110
R358	Same as R324	
L301	50A2928	Peaking Coil Assembly
L302	50A2929	Peaking Coil Assembly
L303	Same as L302	
L304	Same as L301	
	ELCO	Tube Socket 623BC
	Grayhill	Sleeve 31B-1 (Black)
	Grayhill	Sleeve 31B-6 (Blue)

TIMER P.C. BOARD ASSEMBLY
Reference Schematic 50D349

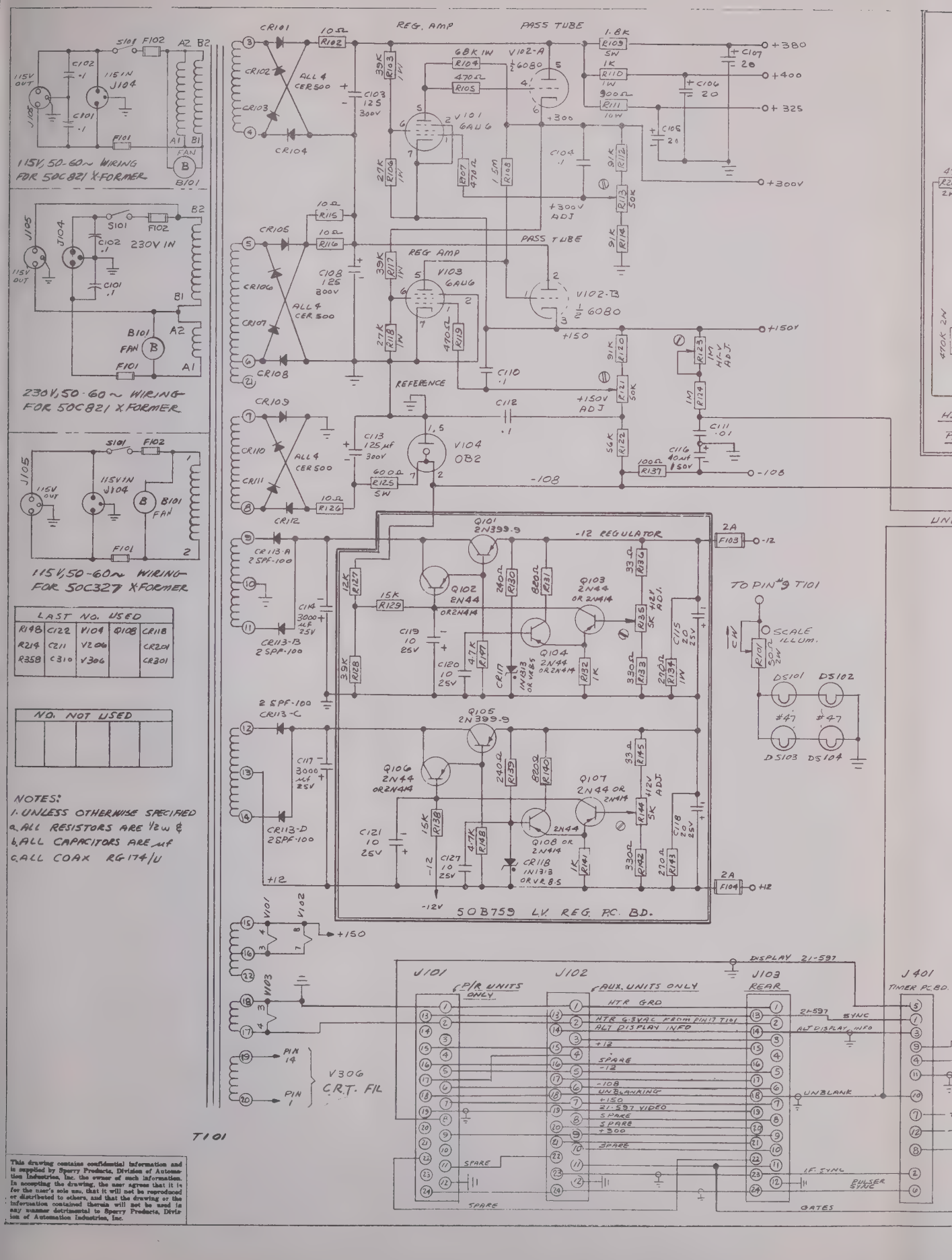
Schematic Symbol No.	Sperry Part No.	Description
C401	Centralab	Capacitor 150uuf DD-151
C402	Centralab	Capacitor .001uf DD-102G
C403	Centralab	Capacitor 68uuf DD-680
C404	Sprague	Capacitor .039uf 65P39352
C405	Sprague	Capacitor .001uf 65P10253
C406	Sprague	Capacitor .002uf 65P20253
C407	Same as C403	
C408	Centralab	Capacitor 750uuf DD-751
C409	Arco	Capacitor .005uf 100v ± 2% 1PJ-502G
C410	Arco	Capacitor .05uf 100v ± 2% 1PJ-503G
C411	Arco	Capacitor .5uf 100v ± 2% 1PJ-504G
C412	Same as C408	
C413	Same as C401	
C414	Same as C402	
C415	Same as C401	
C416	Sprague	Capacitor .22uf 5C9
C417	General Instrument	Capacitor 250uf BL2141
C418	Same as C417	
C419	Sprague	Capacitor .1uf 5C7
C420	Same as C417	
C421	Same as C419	
C422	Same as C417	
C423	Same as C402	
C425	Same as C402	
C426	Centralab	Capacitor 510uuf DD-511
C427	Centralab	Capacitor .05uf UK10-503
C428	Sprague	Capacitor .01uf 65P10352
C429	Centralab	Capacitor .02uf DA-203
C430	Same as C427	
C431	Centralab	Capacitor 470uuf DD-471
C432	Same as C401	
C433	Same as C426	
C434	Same as C426	
C435	Centralab	Capacitor 300uuf DD-301
C436	Arco	Capacitor .0016uf 500v ± 5% CM20B-162J
C437	Arco	Capacitor .0047uf 500v ± 5% CM20B-472J
C438	Arco	Capacitor .022uf 100v ± 5% 1PJ-223J
C439	Arco	Capacitor 510uuf 500v ± 5% CM20B-511J
C440	Same as C437	
C441	Same as C438	
C442	Centralab	Capacitor 47uuf DD-470
C443	Centralab	Capacitor 200uuf DD-201
C444	Sprague	Capacitor .002uf 125LD20
C445	Same as C443	
C446	Same as C443	
C447	Same as C428	
C448	Sprague	Capacitor .0015uf 65P15253
C449	Erie	Capacitor .1uf 200v 89625U1042
C450	Same as C403	
CR401	1N90	Diode
CR402	1N456A	
CR403	Same as CR402	
CR404	1N914A	Diode
CR405	1N2326	Diode
CR406	Same as CR401	Diode
CR407	Same as CR402	
CR408	1N1313A	Diode
CR409	Same as CR401	
CR410	Same as CR402	

TIMER P. C. BOARD ASSEMBLY (cont)
Reference Schematic 50D349

Schematic Symbol No.	Sperry Part No.	Description
R436	DPA004B08	Resistor 200 ohms 1/2W ± 5%
R437	Same as R436	
R438	Same as R429	
R439	DPA004B01	Resistor 100 ohms 1/2W ± 5%
R440	DPA006B18	Resistor 510 ohms 1W ± 5%
R441	Same as R424	
R442	DPA004C18	Resistor 5.1K 1/2W ± 5%
R443	Same as R442	
R444	Same as R440	
R445	Same as R414	
R446	DPA004C11	Resistor 2.7K 1/2W ± 5%
R447	Same as R416	
R448	Same as R442	
R449	Same as R442	
R450	DPA004A01	Resistor 10 ohms 1/2W ± 5%
R451	Same as R429	
R452	Same as R424	
R453	DPA004D01	Resistor 10K 1/2W ± 5%
R454	Same as R439	
R455	Same as R405	
R456	Same as R407	
R457	Same as R407	
R458	Same as R428	
R459	Same as R414	
R460	Same as R408	
R461	Same as R436	
R462	DPA004B12	Resistor 300 ohms 1/2W ± 5%
R463	Same as R407	
R464	Same as R453	
R466	Same as R462	
R467	DPA004C21	Resistor 6.8K 1/2W ± 5%
R468	DPA004B22	Resistor 750 ohms 1/2W ± 5%
R469	Same as R414	
R470	DPA004D24	Resistor 91K 1/2W ± 5%
R471	Same as R470	
R472	Same as R414	
R473	Same as R439	
R474	Same as R467	
R475	Same as R462	
R476	Same as R424	
R477	Same as R405	
Q401	2N1308	Transistor
Q402	2N1309	Transistor
Q403	2N585	Transistor
Q404	2N384	Transistor
Q405	Same as Q401	
Q406	2N1605A	Transistor
Q407	Same as Q402	
Q408	Same as Q401	
Q409	Same as Q406	
Q410	2N414	Transistor
Q411	2N404A	Transistor
Q412	Same as Q411	
Q413	2N1170	Transistor
Q414	Same as Q403	
Q415	Same as Q411	
Q416	Same as Q403	
Q417	2N1301	Transistor
Q418 thru Q421	Same as Q417	
	ELCO	Socket 3303
	ELCO	Connector 8102-10-4-1A
	ELCO	Connector 8102-12-4-1A

TIMER ASSEMBLY
Reference Schematic 50D349

Schematic Symbol No.	Sperry Part No.	Description
R501	50A3122	Potentiometer 5K ohms
R502	DPA004D02	Resistor 11K 1/2W ± 5%
R503	DPA004D10	Resistor 24K 1/2W ± 5%
R504	50A3146	Potentiometer 25K ohms
R505		Resistor 5.6K 1/4W ± 5%
R506	50A3124	Potentiometer 5K ohms
R507		Resistor 3.3K 1/4W ± 5%
R508		Resistor 910 ohms 1/4W ± 5%
R509	50A3123	Potentiometer 500 ohms
R510		Resistor 470 ohms 1/4W ± 5%
R511	Same as R506	
R512	DPA004A13	Resistor 33 ohms 1/2W ± 5%
R513	50A3141	Potentiometer 500 ohms
R514	DPA004D04	Resistor 13K 1/2W ± 5%
R515	Same as R501	
R516	50A3117	Potentiometer 2.5K ohms
R517	Same as R506	
S501	50A3144	Switch
S502	50A3115	Lever Switch, LH
S503	50A3114	Lever Switch, RH
S504	50A3139	Switch
S505	50A3155	Toggle Switch



LAST NO. USED				
R148	C122	V104	Q108	CR118
R214	C211	V206		CR201
R358	C310	V306		CR301

NO. NOT USED				

NOTES:
1. UNLESS OTHERWISE SPECIFIED
a. ALL RESISTORS ARE 1/2W ±
b. ALL CAPACITORS ARE µf
c. ALL COAX RG174/U

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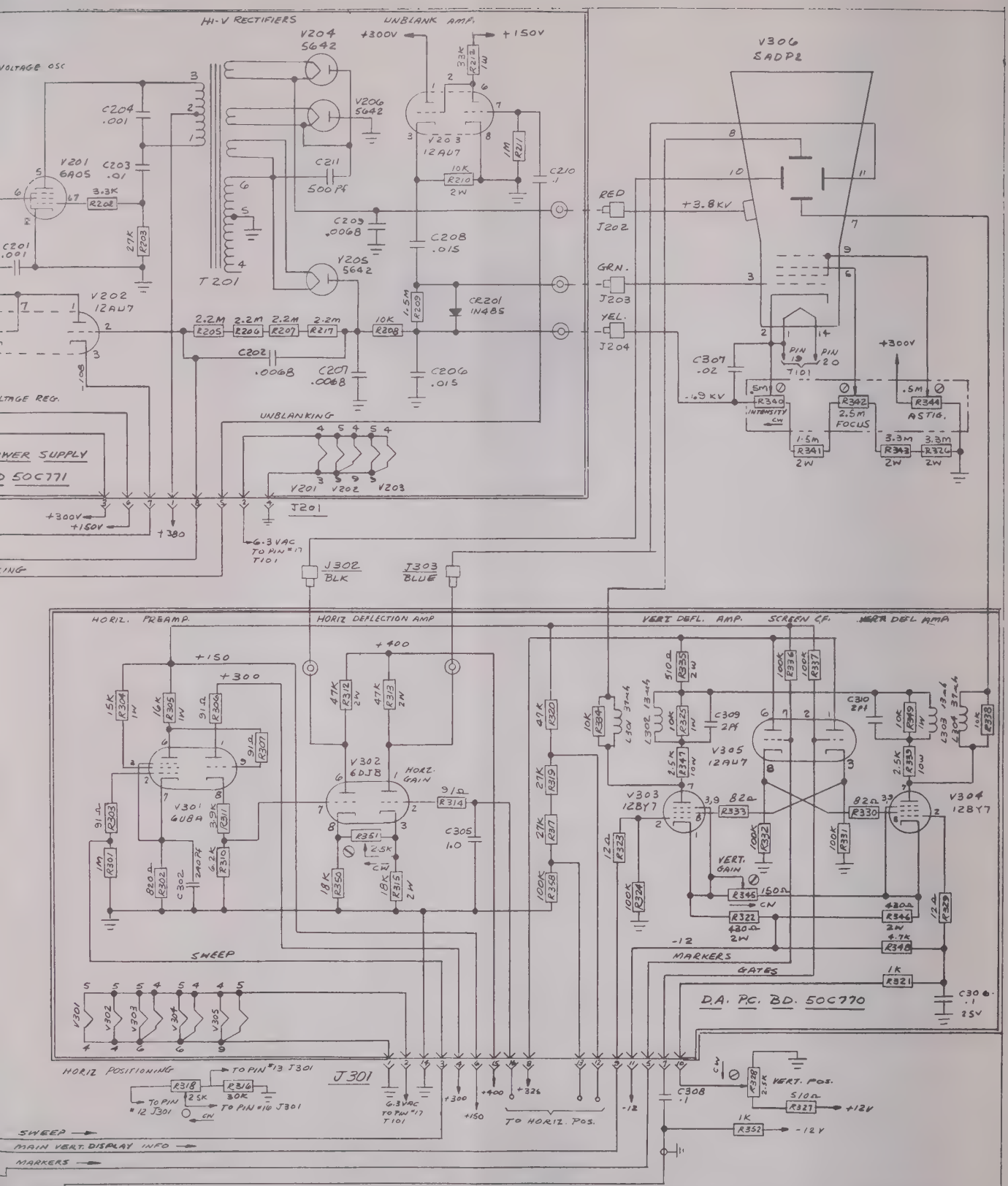
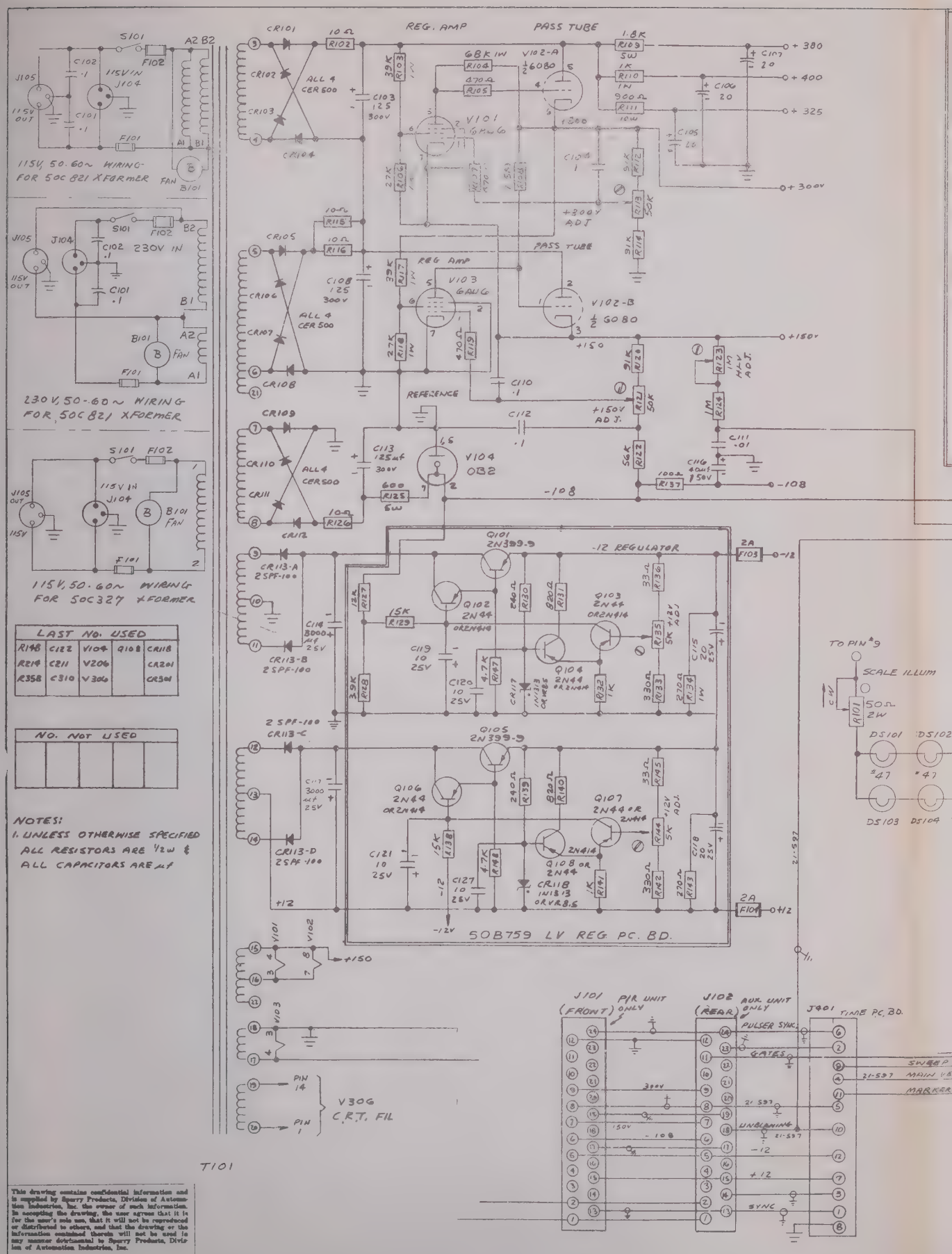

HI-V RECTIFIERS
UNBLANK AMP.
V204 5642
+300V
+150V
V206 5642
V205 5642
V203 12AU7
V201 6AQ5
V202 12AU7
T201
C204 .001
C203 .01
C201 .001
C211 500 PF
C209 .0068
C208 .015
C210 .1
C202 .0068
C207 .0068
C206 .015
CR201 IN485
R201 2.2M
R202 2.2M
R207 2.2M
R217 2.2M
R208 10K
R209 4.5M
R211 1M
R210 10K 2W
R212 33K 1W
R203 27K
R204 3.3K
UNBLANKING
J201
+300V
+150V
+380
6.3 VAC TO PIN #17 T101
J302 BLK
J303 BLUE
V306 5ADP2
RED J202
GRN. J203
YEL. J204
+3.8 KV
C307 .02
-1.9 KV
PIN 19
PIN 20
T101
+300V
R340 INTENSITY CW
R342 2.5M FOCUS
R344 ASTIG.
R341 1.5M 2W
R343 3.3M 2W
R326 3.3M 2W
HORIZ. PREAMP.
HORIZ DEFLECTION AMP
VERT DEFL. AMP.
SCREEN CP.
VERT DEFL AMP
+150
+300
+400
V301 6U8A
V302 6DJ8
HORIZ. GAIN
V303 12BY7
V304 12BY7
V305 12AU7
R304 15K 1W
R305 16K 1W
R306 91Ω
R307 91Ω
R303 91Ω
R301 1M
R302 820Ω
C302 240 PF
R310 6.2K
R311 3.9K
R312 47K 2W
R313 47K 2W
R314 91Ω
R351 2.5K CW
R350 18K
R315 18K 2W
C305 1.0
R320 47K
R319 27K
R317 27K
R358 100K
R334 100K
R337 100K
R335 510Ω 2W
R325 10K 1W
R347 2.5K 10W
R333 82Ω
R330 82Ω
R332 100K
R331 100K
R323 12Ω
R324 100K
VERT. GAIN
R346 150Ω CW
R322 430Ω 2W
R346 430Ω 2W
R348 4.7K
R329 12Ω
R321 1K
C309 2PF
C310 2PF
R339 2.5K 10W
R338 10K
-12
MARKERS
GATES
D.A. PC. BD. 50C770
SWEEP
V301
V302
V303
V304
V305
HORIZ POSITIONING
R318 2.5K
R316 30K
TO PIN #13 J301
TO PIN #12 J301
TO PIN #16 J301
CW
J301
6.3VAC TO PIN #17 T101
+300
+150
+400
+326
TO HORIZ. POS.
-12
C308 .1
VERT. POS.
R328 2.5K
R327 510Ω
+12V
1K
R352
-12V
SWEEP
MAIN VERT. DISPLAY INFO
MARKERS



LAST NO. USED				
R148	C122	V104	Q108	CR118
R214	C211	V206		CR201
R358	C310	V306		CR304

NO. NOT USED				

NOTES:
1. UNLESS OTHERWISE SPECIFIED ALL RESISTORS ARE 1/2W & ALL CAPACITORS ARE μf

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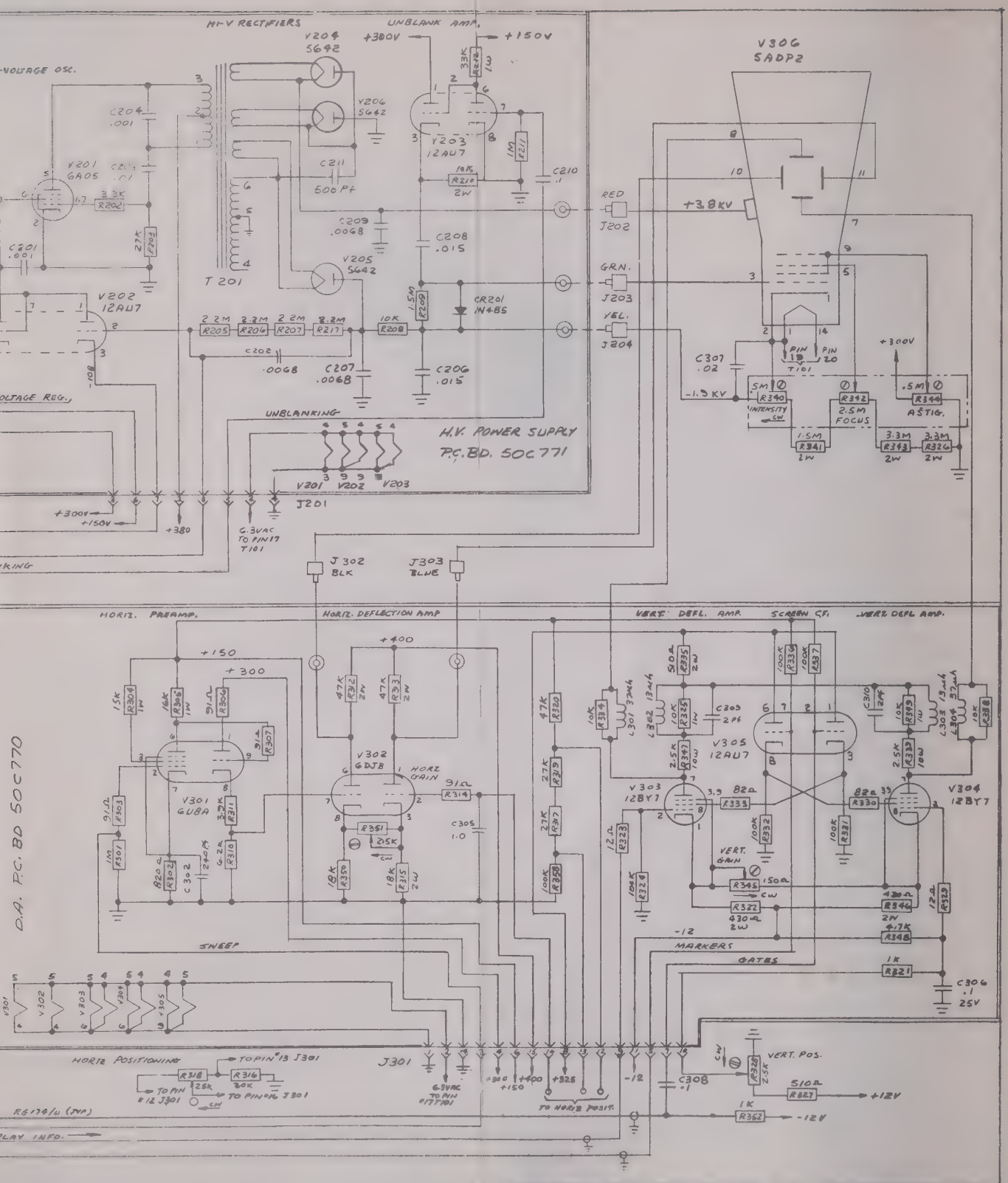
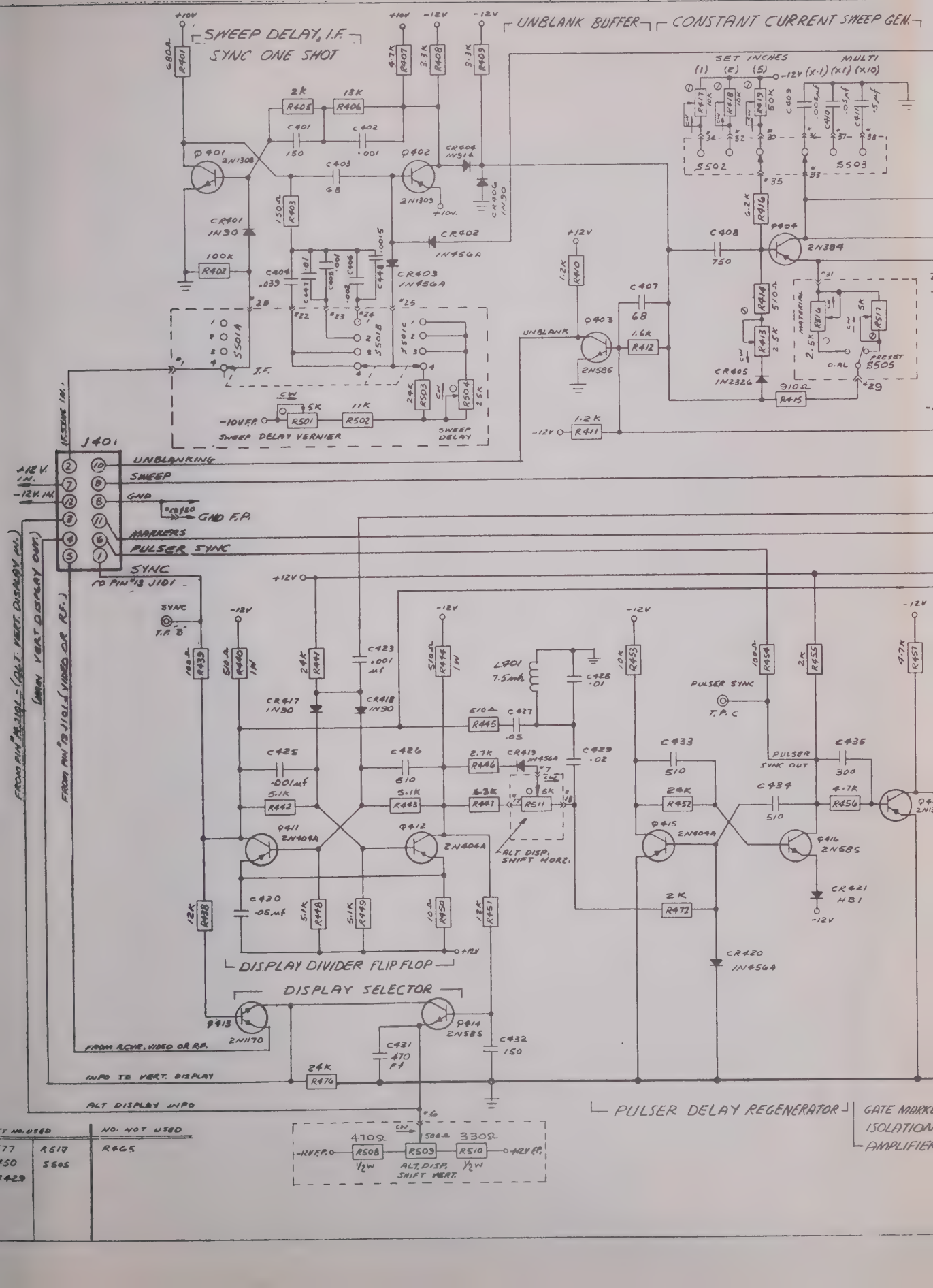
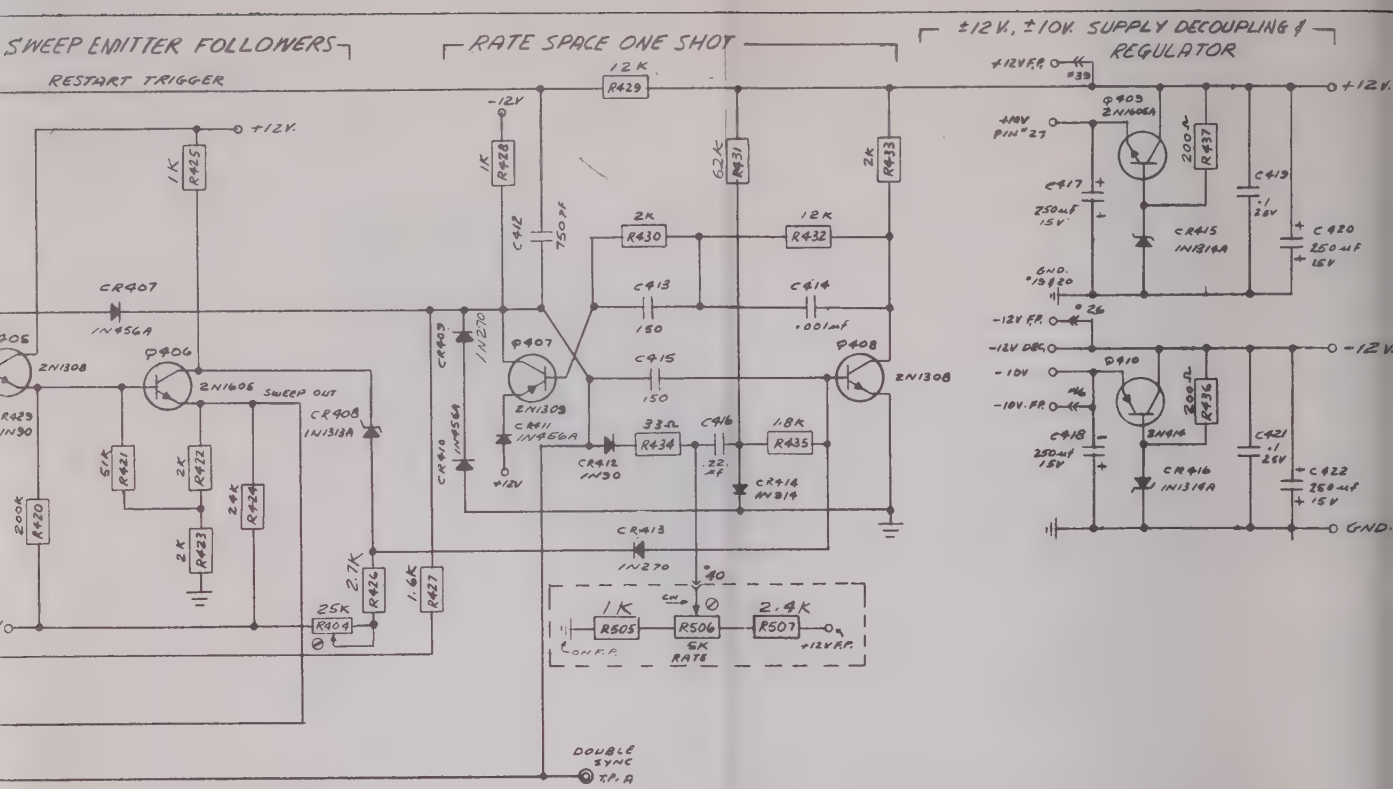
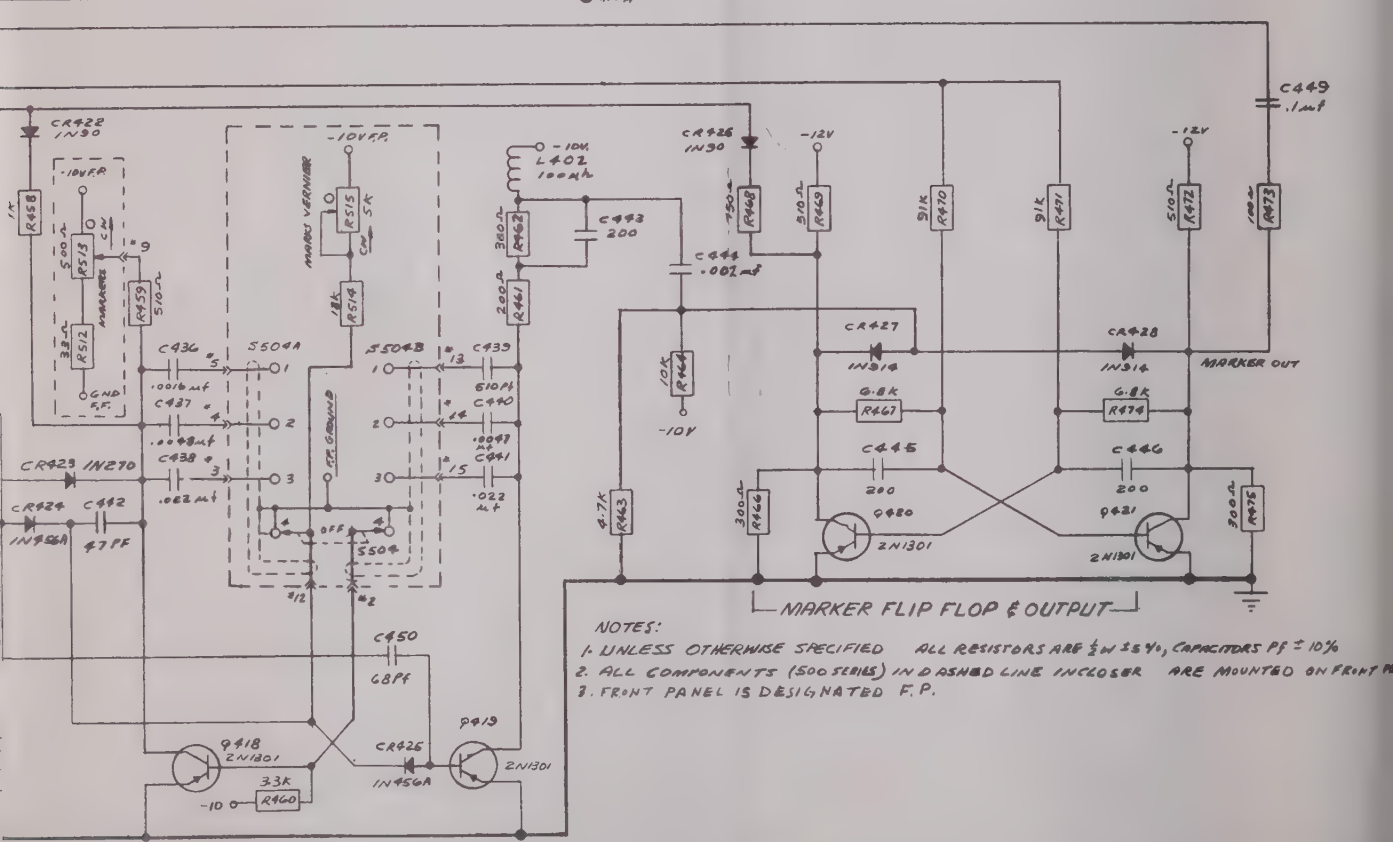


		50B715	SPERRY PRODUCTS
			SCHEMATIC DISPLAY UNIT
			UM715 REFLECTOSCOPE
			50D358
			G.C. 5-17-63
			50D358



PART NO. USED	PART NO. NOT USED
R417	R465
R450	S505
C429	





NOTES:
1. UNLESS OTHERWISE SPECIFIED ALL RESISTORS ARE ½W ±5%, CAPACITORS PF ± 10%
2. ALL COMPONENTS (500 SERIES) IN DASHED LINE ENCLOSER ARE MOUNTED ON FRONT P
3. FRONT PANEL IS DESIGNATED F.P.

LTR	DWG REV	ECN NO	DATE	CHK
D	500352	6885	12-26-63	
C	500352	6739	1-8-64	
B	500352	6665	1-16-64	
A	500352	6625	1-17-64	

SCALE	EXCEPT AS NOTED
DEC ±	
FRAC ±	
ANGLES ±	
MACH ✓	
MAT OR P SPEC	
FINISH	

500352 REF ABS'Y NO

SPERRY PRODUCTS
DIVISION OF AUTOMATION INDUSTRIES, INC.
DANBURY, CONNECTICUT, U.S.A.

SCHEMATIC
TIMER BOARD
SOD349

DRAWN BY GC. 4-23-63
CHECKED BY BMK 6-24-63
APPROVED BY [illegible] 6/24/63

SOD352 REF

SOD 349

SECTION V

ACCESSORY UNITS FOR UM721

GENERAL

The UM721 Reflectoscope has built-in provisions for the addition of one accessory unit. This provision is the only difference between the UM715 and UM721 . Use of the accessory unit permits more flexibility in testing and allows for a wider variety of tests.

The available accessory units are:

Transigate - Style 50E550
UT Gage - Style 53B137
Distance Amplitude Correction - Style 50E551

The accessory units are inserted into the UM-721 cabinet in the space provided; all connections are made through the connector in the rear panel of the cabinet. The connector is completely wired into the basic unit so that no wiring changes are necessary, regardless of the accessory unit used.

TRANSIGATE - STYLE 50E550

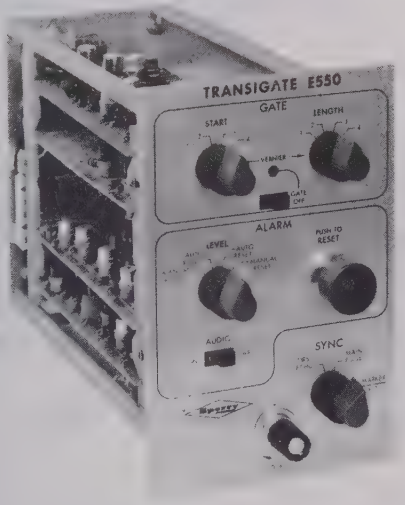


Figure 5-1
Transigate - Style 50E550

The Transigate provides flexibility in ultrasonic inspection systems for semi-automatic or automatic detection of flaws in materials at production speeds. When used with the UM721 the Transigate permits a test piece to be sampled within a specific controlled zone or area. Signals within this zone or gate are passed on to recording and alarm circuits.

Alarm lights, buzzers and relays can be operated. Strip chart or fac-simile recorders can be driven.

Complete details on the operation and use of the Transigate are presen in Section IX of this manual.

UT GAGE - STYLE 53B160

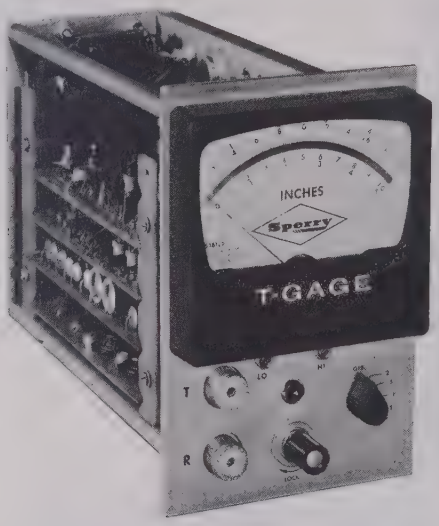


Figure 5-2
UT Gage - Style 53B160

The UT Thickness Gage can be used in conjunction with the UM721 to obtain direct reading indication of thickness of metal and plastic objec The test range covers from .060 to 5.0 inches. Readings are accurat even with corroded or curved surfaces. Measurements are read on a inch mirror scale meter calibrated directly in inches.

The ranges and accuracy of measurement are:

Range	Accuracy
Smooth surfaces: all 4 ranges	± 1% of full scale
Rough or curved surfaces:	Accuracy will be slightly reduce .2", .5" and 1" range and will on the degree of roughness and ness.

NOTE
Accuracies will change approximately .5% for each 20°F change in ambient temperature from calibration temperature.

The UT Gage is available as a separate operating component; in this instance, the instrument is supplied with a case and is operated by internal silver cadmium batteries. When used with the UM721, the UT Gage is removed from its case and inserted in the UM721 accessory slot. Power is then supplied from the UM721 power supply. All other operation remains the same.

Additional information on the UT Gage is presented in the Instruction Manual for the instrument.

DISTANCE AMPLITUDE CORRECTION UNIT- STYLE 50E551

Figure 5-3
Distance Amplitude Correction Unit - Style 50E551

The DAC Unit extends the capability of the UM721 Reflectoscope to permit correction of signal response from "near field" and "far field" zones of the test piece. In ultrasonic testing, interpretation of flaw size requires recognition of the continuous change in echo signal from a given size flaw as a function of its distance from the testing surface. This change in echo signal is non-linear and usually bi-directional. The response increases for a short distance, "near field" zone; reaches a peak, "near field" limit; and decreases throughout the remainder of the test piece, "far field."

The DAC Unit provides for the correction of signal response in both zones, to give essentially a flat response regardless of defect distance from the surface. In other words, regardless of the distance of the defect from the entrant surface, the response, assuming identical defect size, will be constant. Thus, any change in response is attributable to defect size and not to depth.

Complete details for the DAC unit are given in Section VII of this manual.

SECTION VI

PULSER/RECEIVER UNITS 5B, 1N, 2.25N, 5N, 10N, AND HFN

DESCRIPTION

1. GENERAL (Figure 6-1, 6-2, and 6-3)

The Pulser/Receiver units are designed as plug-in components with a quick disconnect feature for interchange or servicing. They contain the circuitry for the generation and transmission of high frequency pulses to the transducer, for receiving, amplifying, and detecting the high frequency echo or return pulses from the test specimen, and for limiting and transferring the detected video pulses to the Time Control Unit and thence to the Reflectoscope Display and any accessory equipment in use.

Figure 6-1
Pulser/Receiver Unit 5N, Typical For 1N, 2.25N And 10N

The numerical designators in the titles refer to the highest frequency (in megacycles) obtainable with a given unit. The HFN unit (figure 6-2)

is a special case in that the operating frequency is determined by the plug-in tuning board selected. Specific details of this unit's design are discussed later in this section. The 5B unit is an early type and is not covered extensively in this section; however, details of its operation are similar to the other units, and an overall schematic is included.

Figure 6-2
Pulser/Receiver Unit HFN

The early 5B unit was designed for operation with barium titanate, lead zirconate, or other ceramic transducers. The 5N and succeeding types were developed for operation with high impedance quartz or lithium sulphate transducers, as well as low impedance barium titanate, lead zirconate, and lead metaniobate transducers.

Table 6-1 contains information on operating frequencies and other characteristics which will help to clarify the differences between the Pulser/Receiver types.

TABLE 6-1
PULSER/RECEIVER TYPES

UNIT	OPERATING FREQUENCIES	COMMENTS
5B (50E523)	1.0 mc. 2.25 mc. 5.0 mc.	Designed primarily for ceramic type transducers; overall schematic in rear of section.
1N (50C529)	0.2 mc. 0.4 mc. 1.0 mc.	Different frequency range, circuitry similar to 5N.
2.25 N (50C391)	0.4 mc. 1.0 mc. 2.25 mc.	Different frequency range, circuitry similar to 5N.
5N (50C524)	1.0 mc. 2.25 mc. 5.0 mc.	Designed for all transducer types.
10N (50C519)	2.25 mc. 5.0 mc. 10.0 mc.	Different frequency range, circuitry similar to 5N.
HFN (50C390)	As selected by choice of plug-in tuning board	Design basically same as 5N, except frequency selection is by insertion of specified plug-in tuning circuit boards.

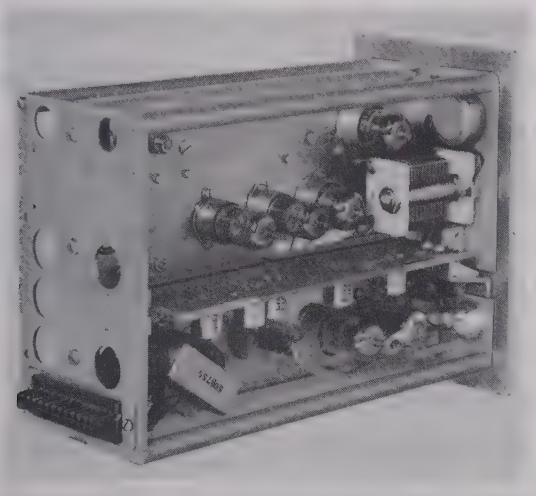


Figure 6-3
Pulser/Receiver HFN, Showing Plug-In Tuning Board Design

The Pulser/Receiver units consist of the following major components:

a. TRIGGER AMPLIFIER

Shapes and amplifies the timing signal from the Time Control Unit and furnishes a trigger pulse to the pulser circuit.

b. PULSER

Supplies a high voltage, high frequency pulse to the transducer (search unit).

c. TIME DELAY AND HIGH VOLTAGE CIRCUIT

Allows 30 second time delay for warm-up before applying high voltage to pulser thyratron.

d. RF AMPLIFIER

Receives and amplifies return (echo) high frequency pulses from transducer (search unit) and furnishes pulse to video detector.

e. FREQUENCY SELECTOR

Selects inductance values in RF Amplifier and Pulser circuits to tune unit at selected operating frequency.

f. TUNING CIRCUIT BOARD (HFN UNIT ONLY)

Plug-in circuit board containing predetermined fixed values of inductance and capacitance which tune unit at chosen operating frequency; performs function of frequency selector switch in other units.

g. VIDEO DETECTOR

Converts high frequency pulses from the RF Amplifier to video pulse signals; provides output to video gate in Time Control Unit and thence to final amplifiers in Display Unit and any accessory equipment being used.

h. LIMITER AND OUTPUT CIRCUIT

Limits maximum amplitude of video pulse (6 volts in 5B, 1N, 2.25N, 5N; adjustable in 10N and HFN) and provides low impedance coupling for output pulses.

2. MECHANICAL SPECIFICATIONS

The Pulser/Receiver units plug in to the UM Reflectoscope or Special Function cabinet and make automatic contact with other units through a plug at the rear of the chassis. The unit is easily removed for

servicing or interchange by releasing the front catch and pulling it out.

The following front panel controls are provided:

a. PULSER CONTROLS:

PULSE LENGTH

PULSE TUNING

b. GAIN CONTROLS:

COARSE SENSITIVITY (switch; except in HFN)

FINE SENSITIVITY

c. VIDEO CONTROLS:

REJECT

d. FREQUENCY CONTROLS:

FREQUENCY (switch; except in HFN)

e. TEST CONTROLS:

TEST (switch)

f. RECEPTACLES:

RECEIVER (left)

TRANSMITTER (right)

3. ELECTRICAL SPECIFICATIONS

All power requirements are obtained from the UM Reflectoscope through automatic mating of connectors when the unit is installed. The timing signal from the Time Control Unit is obtained in the same manner; as is the transfer of the video signal to the Time Control Unit.

OPERATION

1. FUNCTION OF CONTROLS (Figure 6-1 and 6-2)

   a. PULSER CONTROLS

      (1) PULSE LENGTH

      The PULSE LENGTH control is used to adjust the time duration of the high frequency pulse applied to the transducer (search unit). It should be adjusted to maximize signal return while maintaining required resolution. (It should be left near minimum and increased only to gain signal strength if maximum sensitivity does not suffice; excessive pulse length can obscure signals from defects close to the test surface.)

      (2) PULSE TUNING

      The PULSE TUNING control is a capacitive adjustment which compensates for slight variations in distributed capacitance and other characteristics between cables and transducers. Depending on the requirements of the test situation, it should be adjusted to produce either the largest or most distinct indications.

   b. GAIN CONTROLS

      (1) COARSE SENSITIVITY (switch)

      The COARSE SENSITIVITY switch adjusts the gain of the RF Amplifier in three ranges: X.1, X1, and X10.

      (2) FINE SENSITIVITY

      The FINE SENSITIVITY control provides a continuous adjustment of RF Amplifier gain within the ranges noted above.

   c. VIDEO CONTROL

      (1) REJECT

      The REJECT control in the video detector is used to block passage of low level irrelevant signals and noise signals for a clean CRT presentation which permits easier interpretation of echo signals. See Familiarization Section regarding cautions to be observed in using the REJECT control.

d. FREQUENCY CONTROLS

(1) FREQUENCY (switch)

The FREQUENCY selector switch selects the operating frequency for the unit in use. The selected frequency normally corresponds to the operating frequency of the transducer (search unit) being used. The various frequencies available are listed in Table 6-1. (In the HFN unit there is no FREQUENCY switch; its functions are performed by the individual plug-in tuning circuit boards.)

e. TEST CONTROLS

(1) TEST (switch)

The TEST switch is a two position switch which selects one of two possible test modes, THRU and NORMAL. In the THRU position two transducers (search units) are used; one transmits the high frequency pulse to the test specimen, the other receives the signals from the test specimen and sends pulses to the RF Amplifier via the RECEIVER jack. In the NORMAL position, only one transducer is used, and this acts as both transmitter and receiver of the high frequency pulse.

f. RECEPTACLES

(1) RECEIVER (left)

The left receptacle marked "R" is used under the following conditions:

(a) When testing with pulse-echo (one transducer or search unit - TEST switch on NORMAL) technique and using quartz or lithium sulfate transducers with short cable.

(b) Receiver cable is plugged in here when using through transmission technique (two transducers - TEST switch on THRU).

(2) TRANSMITTER (right)

The right receptacle marked "T" is used under the following conditions:

(a) When testing with pulse-echo (one transducer) technique and using barium titanate, lead zirconate, or lead metaniobate types, or when cable is longer than 6'4".

(b) Transmitter cable is plugged in here when using through transmission technique.

2. FAMILIARIZATION (Figure 6-1, 6-2 and 6-3)

a. FAMILIARIZATION - GENERAL

The detailed discussion of operating techniques given in the Familiarization Section of this manual should be consulted to supplement the basic information given here.

(1) Assemble a Search Unit, a UM Reflectoscope complete with Time Control Unit, Display Unit, and Pulser/Receiver, and a test specimen.

NOTE

Always turn power off when plugging components in or taking them out.

(2) Make sure that the Pulser/Receiver is set to the proper operating frequency. This is determined by the operating frequency of the search unit being used.

(a) With the 5B, 1N, 2.25N, 5N, and 10N units, this is accomplished with the FREQUENCY switch (figure 6-1).

(b) With the HFN unit, operating frequency is set by insertion of the proper plug-in tuning circuit board (figure 6-3). When the board is seated, the selected frequency will appear in the small window on the front panel (figure 6-2).

(3) Obtain a trace on the CRT with the initial pulse and an echo pulse from the test specimen appearing on it.

(a) Move the COARSE SENSITIVITY switch (no switch on HFN unit) from X.1 to X1 to X10 and note that the amplitudes of the signals increase in broad steps.

(b) Turn the FINE SENSITIVITY control and note that it will control the amplitude of the signals within the ranges set by the COARSE switch. As the COARSE switch is moved from X.1 to X10 it will be necessary to decrease the FINE control to maintain a normal signal amplitude on the screen.

(4) Manipulate the PULSE LENGTH and PULSE TUNING controls and note their effects. The LENGTH control will affect the signal amplitude and will also affect the width of the initial pulse and echo signal. The amplitude will increase with increased width. (Since increasing the width of the initial pulse may obscure echo signals from discontinuities close to the entrant surface, the PULSE LENGTH control should be used with discretion and increased only when the sensitivity controls cannot provide sufficient signal amplitude.) Note that signal amplitude and appearance can be improved by use of the PULSE TUNING control; this "trims" the Pulser/Receiver for optimum operation with a given cable and transducer.

(5) With the REJECT control CCW, note that the sweep outside of the initial pulse and echo signals tends not to be "clean". Small random signals from the test specimen and noise signals from the unit ("grass") appear all along the sweep. By adjusting the REJECT control CW it should be possible to clean up the sweep by eliminating all but the initial pulse and desired echo signal.

(6) Before attempting to test under specific requirements, study carefully the information on operating techniques given in the forward section of this manual and be sure to familiarize yourself with any accessory or recording equipment being used with the Reflectoscope.

INCIPLES OF OPERATION

GENERAL

Figure 6-4 is a block diagram of a Pulser/Receiver unit which is typical for all except the early 5B unit; however, the 5B unit is not markedly different. An overall schematic of the 5B is provided in the rear of this section, and Table 6-2 in the rear of the Principles of Operation summarizes the small design differences between all the Pulser/Receiver types.

The trigger amplifier receives a timing signal from the Time Control Unit and shapes and amplifies it. It then furnishes a 200 volt positive trigger signal to the pulser circuit.

When it is triggered the pulser circuit furnishes a high frequency pulse which is sent to the transducer through either the "R" or "T" jack, depending on the position of the TEST switch and the requirements of the test situation. High plate voltage (1000 volts) for the pulser thyratron is provided by the high voltage rectifier and step-up transformer. The time delay relay provides for warm-up before the high voltage is applied.

The frequency selector switch (or plug-in board with the HFN) places the proper amount of inductance in the resonant circuit of the pulser for the chosen operating frequency.

The echo pulse, either from the one transducer with pulse-echo or "normal" technique, or from the receiving transducer with through transmission technique, is applied to the input of the RF Amplifier through either the "T" or "R" jack and the TEST switch.

The RF Amplifier amplifies the high frequency echo pulses through four stages of amplification. The frequency selector selects the proper amount of tuning inductance for the four stages at the chosen operating frequency. The gain of the RF amplifier is controlled in steps by the COARSE SENSITIVITY switch (no switch on the HFN) and continuously by the FINE SENSITIVITY control.

The amplified high frequency pulse is applied to the video detector circuit where it is converted to a video pulse. The REJECT control sets the point at which the detector will not pass low level signals and allows only echo signals exceeding the set level to pass to the limiter and output circuit.

limiter and output circuit limits the maximum signal strength
ch will be passed (6 volts in the 5B, 1N, 2.25N, and 5N; adjustable
he 10N and HFN) to insure an on screen signal top, and provides
impedance coupling of the video signal to the video gate in the
ne Control Unit.

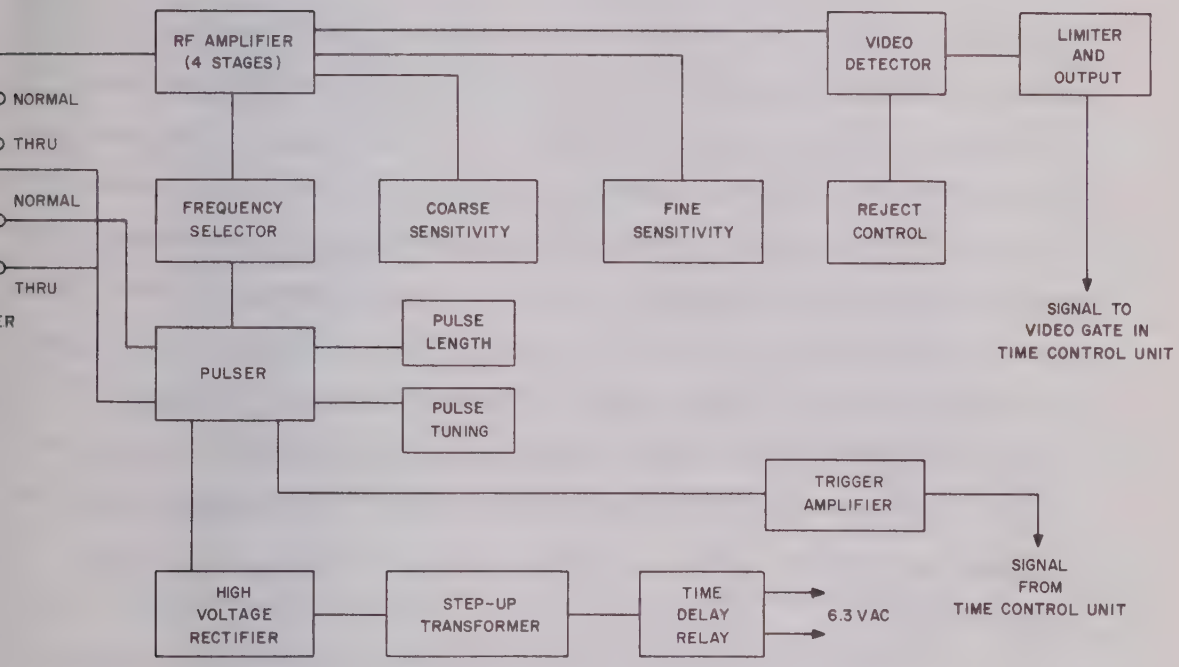


Figure 6-4
Block Diagram of Pulser/Receiver 5N (Typical)

2. DETAILED THEORY

During the following discussion reference should be made to the overall schematic of the 5N unit as typical. Table 6-2, at the end of this discussion, summarizes the major differences between types, and the more important differences are spelled out in the discussion. (The numbers in triangles on the schematic refer to the waveshapes contained in Section VII.)

The timing waveform (sync) from the Time Control Unit is brought in at pin 24 of J101 and is applied to the differentiating network C116 and R132. The square wave is differentiated to produce a peaked wave. The grid (pin2) of V101A is held at a positive potential by the resistive divider R133 and R132 so that only the negative going excursion is passed through amplifier V101A. This produces a positive going trigger pulse at the plate of V101A which is RC coupled to the grid (held at a negative reference level through R138) of cathode follower V101B. The cathode follower produces a sharply defined positive going 200 volt trigger pulse at pin 8 which is applied to the grid of pulse thyratron V102. This trigger pulse is coincident with the leading edge of the negative half-cycle of the timer square wave.

Thyratron pulser V102 produces high frequency pulses which, through capacitor C118, are applied to the search unit (transducer) through J102 or J103 depending on the position of the TEST switch S103 and the demands of the testing situation. The repetition rate of the pulses is, of course, controlled by the timing signal from the Time Control Unit as described in the above paragraph. The frequency of the oscillations within the pulse and the pulse duration are established by a resistive, capacitive, and inductive network comprised of R129, PULSE LENGTH; C115, PULSE TUNING; and either L105, L106, or L107, depending on the position of FREQUENCY selector switch S101. (In the HFN unit, the amount of inductance is determined by the plug-in tuning board selected.) In addition to forming part of the ringing or resonant circuit for the pulser, L105, L106, or L107 couples the output pulse to the transducer and the return or echo

pulse to the RF Amplifier by autotransformer action. PULSE TUNING capacitor C115 is in parallel with the resonant circuit and trims the circuit to compensate for transducer and cable differences. PULSE LENGTH potentiometer R129 is also in parallel with the resonant circuit and affects the Q or ringing time and therefore the pulse duration or width.

Pulser tube V102 operates at a relatively high plate voltage of 1000 volts. Time delay relay K101, step-up transformer T101, and the full wave rectifier comprised of CR103, CR104, CR105 and CR106 combine to help supply the 1000 volts. The time delay permits sufficient warm-up before the high plate voltage is applied to the tube. T101 steps up the 6.3vac which is then rectified. Filtering is accomplished by capacitors C119 and C120 and resistors R140 and R145. The output of the rectifier is 700 volts, but since one side is referenced to the 300 volts B+ derived from the Display Unit the effective plate voltage for V102 is 1000 volts. (Should K101 fail the pulser will still operate but with reduced signal strength.)

The RF Amplifier comprised of V103, V104, V105, and V106 (heaters operating on 12 volts direct current) accepts return or echo signals from the transducer and, after amplifying them through four stages, delivers them to the video detector. The RF Amplifier is synchronously tuned and employs L-C coupling between stages - C101, C102, C103, C104, and proper inductance for the chosen operating frequency as selected by FREQUENCY selector switch sections S101-3F, S101-3R, S101-4F, and S101-4R. (In the HFN unit the amount of inductance is determined by the plug-in circuit board selected.)

All units have a COARSE and FINE SENSITIVITY control except the HFN and 5B which have only a FINE SENSITIVITY control. The COARSE control is switch S102 which provides jump steps in amplifier gain by switching in varying amounts of resistance to shunt the inductance in the L-C coupling between the first and second stages of amplification. The controls (R110 and R131) are factory set to give X.1 and X1 ranges - the X10 range has no shunting resistance.

FINE SENSITIVITY control R105 is a potentiometer which with C121 forms a variable RC shunting circuit to ground for the RF signal.

The RF Amplifier delivers the amplified high frequency pulses to the video detector comprised of rectifier diode CR101, impedance matching emitter follower Q102, REJECT control R127, and filter circuit L108 and C123. Conventional detection is performed to obtain a video pulse from the high frequency pulse. At this point in the signal path it is desirable to be able to establish a variable reference point below which low level signals may be rejected so that the video trace may remain "clean" for ease of interpretation of signals. This is accomplished by REJECT control R127 (R147 on the 10N and R137 on the HFN) which is in series with R141 across a positive and negative voltage source. This enables the wiper of R127 to be varied from slightly positive to relatively highly negative which in turn swings CR101 from a slightly forward biased condition to a negatively biased condition. With maximum negative bias only relatively high level signals will be passed to the output circuit.

The video signals are passed to the limiter and output circuit of CR102 and Q101 from which they are passed to the video gate in the Time Control Unit via pin 19 on J101. CR102 is a 6 volt Zener diode which limits the amplitude of the video signals appearing at the base of Q101 and therefore of the signals appearing on the video trace in the Display Unit. This helps prevent misinterpretation of the trace because of large vertical displacements by high level signals. This limiting circuit is basically the same for the 1N, 2.25N, and 5N. The 10N and HFN are different in that a conventional diode is used and biased at a predetermined point to achieve the same effect. In both cases the action is variable; in the 10N the conduction of emitter follower Q103 is used to set the voltage at the junction between C122 and CR102 and this conduction in turn is regulated by the setting of R141, the potentiometer marked "clamp level set" on the schematic. In the HFN, potentiometer R130 forms part of a resistive divider and is used to set the bias on CR102. In the 10N and HFN an additional factory adjustment, R124 or R138, is added so that optimum conditions can be set in the circuit.

TABLE 6-2 •

SUMMARY OF MAJOR DIFFERENCES — REFERENCED TO 5N

CIRCUIT	1N	2.25N	10N	HFN
Trigger Amplifier (V101)	Same	Same	Same	Same
Pulser (V102)	Plate Resistor changed. C118 changed. L105, 106, 107 inductance value changed. PULSE LENGTH control same.	Plate Resistor changed. C118 changed. L105, 106, 107 inductance value changed. PULSE LENGTH control same.	Plate Resistor same. Capacitor selected by S101. L105, 106, 107 inductance value changed. PULSE LENGTH control changed.	Plate Resistor changed. Capacitor part of plug-in board. Inductance for resonant circuit on plug-in board. PULSE LENGTH control changed.
RF Amplifier (V103, V104, V105, V106)	Inductance values changed. Capacitance added to tuning circuits. COARSE SENSITIVITY same. V103, V104 same.	Inductance values changed. No added capacitance. COARSE SENSITIVITY same. V103, V104 same	Inductance values changed. No added capacitance. COARSE SENSITIVITY same V103, V104 same.	Inductance on plug-in circuit board. No added capacitance. No COARSE SENSITIVITY control. V103, V104 high performance tubes.
Video Detector (CR101, Q102)	Same.	Same.	Bias adjust added.	Bias adjust added.
Limiter and output circuit (CR102, Q101)	Same.	Same.	Limiting circuit changed.	Limiting circuit changed.

PULSER/RECEIVER UNIT

CONTROL	SETTINGS	CONTROL	SETTINGS
PULSE LENGTH	CCW	COARSE SENSITIVITY	X1
PULSE TUNING	MID RANGE	FINE SENSITIVITY	MID RANGE
REJECT	CCW	FREQUENCY	OPTIONAL
TEST	NORMAL	FREQUENCY (HFN)	BOARD IN

PULSER/RECEIVER UNIT IRREGULAR OR INOPERATIVE

Check that unit is properly in place, UM Reflectoscope is operating properly, cables are connected and firmly seated, controls on Pulser/Receiver are set as above.

Remove Pulser/Receiver and visually inspect for loose or missing tubes or transistors, poor connections on wires or components, burned components, or other obvious trouble.

Weak video signal

Wrong frequency selected for transducer, or defective transducer.

On HFN, plug-in board not seated.

Time Delay Relay K101 defective.

H. V. Rectifier circuit defective.

Check tubes, transistors, supply voltages and waveshapes (Section VII).

No video signal

TEST switch in wrong position.

Defective Time Control or Display unit. Check waveform on pin 19, J101.

On HFN, plug-in board not seated.

Check tubes, transistors, supply voltages and waveshapes (Section VII).

MODEL 5NRF

GENERAL

The 5NRF Pulser/Receiver unit will provide the same ultrasonic testing performance as the model 5N Pulser/Receiver, with the exception that the output echo signals to the CRT display are radio frequency (RF) signals rather than video (filtered undirectional pulses). The amplified RF echoes appear on the CRT display identical to the signals received in the search unit. By utilizing this method, complete signal analysis is obtained for critical applications. The video would essentially provide the same information with the exception that the video filter reduces the frequency response and removes important signal features required for effective signal analysis.

CIRCUIT DESCRIPTION

The 5NRF uses circuitry identical to the 5N except for the fourth RF amplifier and output stages. The fourth RF amplifier utilizes tuning coils connected directly to the plate of the vacuum tube. Signals are capacitor coupled through C114 and C109 to two separate detector circuits. The purpose of the two detectors is to provide reject control. Each half of the signal has the lower portion clipped equally as the reject control is turned clockwise. These detected signals are impedance matched to the output through emitter followers Q101 and Q102. The positive and negative halves are integrated by the summing network R114 and R126 for providing bi-directional RF signals at the output.

MODIFICATIONS

1. GENERAL

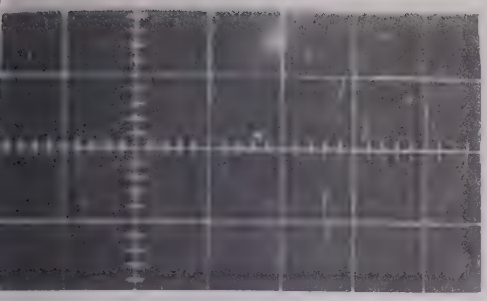
Minor modifications are required on all Pulser/Receiver units bearing serial numbers below S500 to provide overall compatability when used with the UM 715 and UM 721 Reflectoscopes. All subsequent Pulser/Receiver models will contain these modifications; however, it is recommended that the units be inspected to verify incorporation of these changes prior to initial operation.

2. PROCEDURE

Modify the Pulser/Receiver unit as follows:

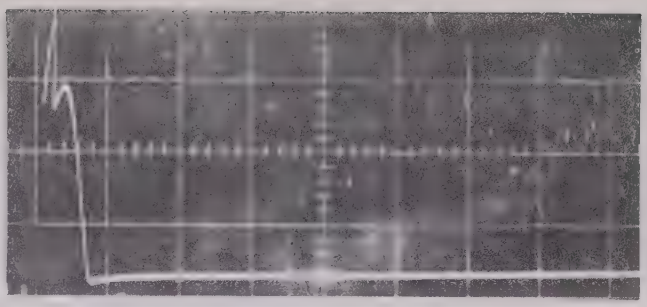
a. Connect jumper from pin 8 to pin 19 on jack J101 of the Pulser/Receiver unit.

b. Change capacitor C116 (capacitor C101 in Pulser/Receiver Model HFN only) from 100 pf to 300 pf.



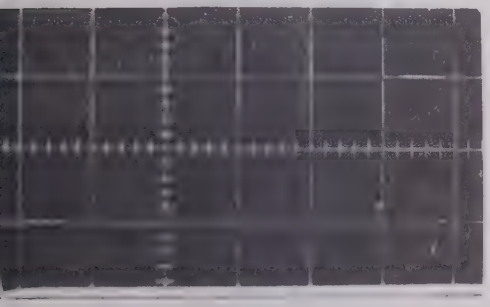
1

EST POINT: V101, pin 2
IME/CM: 10 microsec
OLTS/CM: 1
ASE LINE: 0 Volts



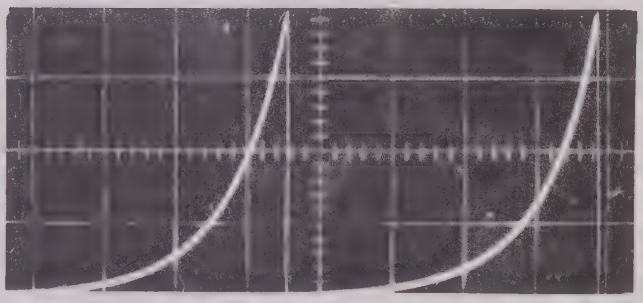
2

TEST POINT: V101, pin 6
TIME/CM 10 microsec
VOLTS/CM: 20
BASE LINE: +5 Volts



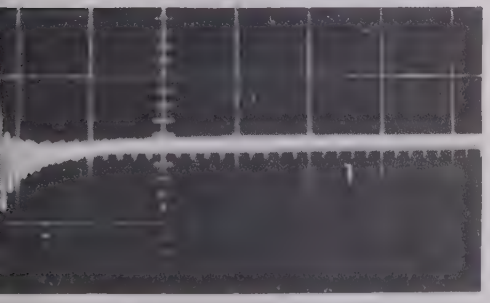
3

ST POINT: V102, pin 1
ME/CM: 0.5 microsec
OLTS/CM: 100
ASE LINE: 0 Volts



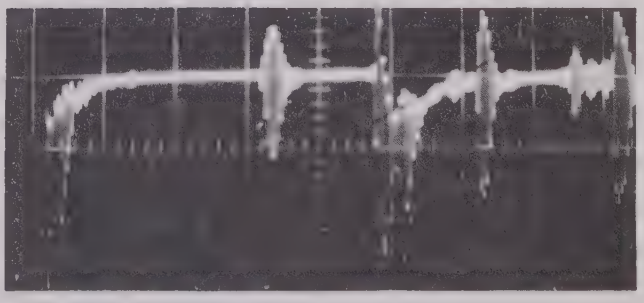
4

TEST POINT: V102, pin 6
TIME/CM: 0.5 millisec
VOLTS/CM: 200



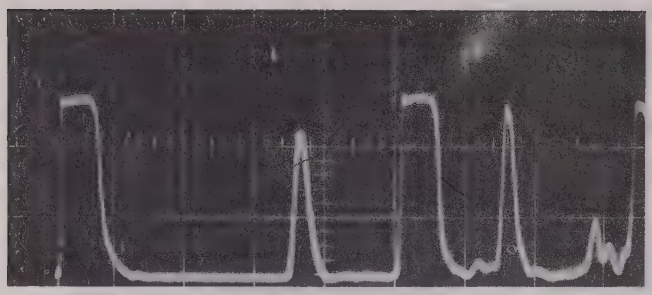
5

ST POINT: R Jack J102
ME/CM: 0.5 microsec
LTS/CM: 1



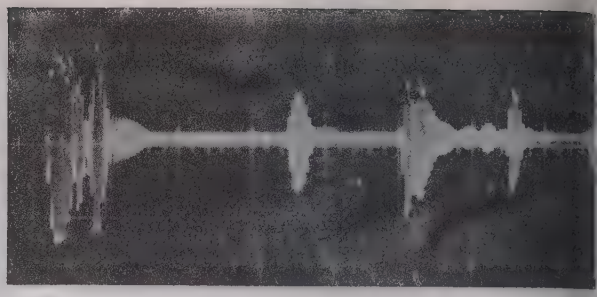
6

TEST POINT: V106, pin 5
TIME/CM: 5 microsec
VOLTS/CM: 10
BASE LINE: +130 Volts



7

APPLICATION: All models
except 5NRF
TEST POINT: J101, pin 19
TIME/CM: 5 microsec
VOLTS/CM: 2



8

APPLICATION: Model 5NRF only
TEST POINT: J101, pin 19
TIME/CM: 5 microsec
VOLTS/CM: 5
BASE LINE: +0.2 Volts

PARTS LIST
PULSER/RECEIVER UNIT 5N
Reference Schematic 50C361

Schematic Symbol No.	Sperry Part No.	Description
C101	DQG002A04	Capacitor . 1uf 200v
C102	DQG002A04	Capacitor . 1uf 200v
C103	DQJ002A37	Capacitor 500uuf 600v
C104	DQJ002A37	Capacitor 500uuf 600v
C105	DQG005A02	Capacitor . 01uf 200v
C106	DQG005A02	Capacitor . 01uf 200v
C107	DQG001B05	Capacitor 2 x . 01uf 600v
C108	Cornell Dubilier	Capacitor 2 x . 01uf 600v
C109	Cornell Dubilier	Capacitor 15uf 25v NL15-25
C110	DQG005A02	Capacitor . 01uf 200v
C111	Sprague	Capacitor . 005uf 50v 125L-D50
C112	ARCO	Capacitor . 0033uf ± 10% 6DP-1-332
C113	Sprague	Capacitor . 005uf 50v 125L-D50
C114	Sprague	Capacitor . 1uf 50v TG-P10
C115	DQE001A07	Capacitor 7. 5 - 100uuf 1200v
C116	DQJ002A32	Capacitor 300uuf 600v
C117	DQJ002A22	Capacitor 100uuf 600v
C118	Cornell Dubilier	Capacitor . 002uf 1600v DPMS16D2
C119	DQL001A63	Capacitor 4uf 450v
C120	DQL001A63	Capacitor 4uf 450v
C121	DQG005A02	Capacitor . 01uf 200v
C122	Sprague	Capacitor . 1uf 50v TG-P10
C123	DQJ002A37	Capacitor 500uuf 600v
C124	Sprague	Capacitor 15uuf 5GA-Q15
C125	DQG001B05	Capacitor . 1uf 400v
C126	Cornell Dubilier	Capacitor 2 x . 01uf 600v BYD6DS1
C127	DQG005A02	Capacitor . 01uf 200v
C128	Sprague	Capacitor . 005uf 50v 125L-D50
C129	DQJ004A26	Capacitor 47uuf 600v
C130	DQG005A02	Capacitor . 01uf
CR101	1N270	Diode
CR102	Hoffman Electronics	Diode 1N709A
CR103	Solitron Devices, Inc.	Diode CER-72
CR104	Solitron Devices, Inc.	Diode CER-72
CR105	Solitron Devices, Inc.	Diode CER-72
CR106	Solitron Devices, Inc.	Diode CER-72
R101	Willrite Prod., Inc.	Resistor 2K 1/2W ± 1% Type CMCS
R102	DPA005B09	Resistor 470 ohms 1/2W
R103	DPA005B09	Resistor 470 ohms 1/2W
R104	DPA009B09	Resistor 470 ohms 2W
R105	50A2478	Potentiometer 2. 5K
R106	DPA004C12	Resistor 3K 1/2W
R107	DPA004C15	Resistor 3. 9K 1/2W
R108	DPA009D01	Resistor 10K 2W
R109	DPA005D01	Resistor 10K 1/2W
R110	Allen Bradley	Potentiometer 500 ohms 1/4W ± 10% Type "R"
R111	DPA005D01	Resistor 10K 1/2W
R112	DPA005D01	Resistor 10K 1/2W
R113	DPA005D01	Resistor 10K 1/2W
R114	Willrite Prod., Inc.	Resistor 150 ohms 1/2W ± 1% Type CMCS
R115	DPA006C08	Resistor 2K 1W ± 5%
R116	DPA005A02	Resistor 12 ohms 1/2W
R117	DPA005A02	Resistor 12 ohms 1/2W
R118	DPA005A02	Resistor 12 ohms 1/2W
R119	Willrite Prod., Inc.	Resistor 10K 1/2W ± 1% Type CMCS
R120	DPA004A21	Resistor 68 ohms 1/2W
R121	DPA004A21	Resistor 68 ohms 1/2W
R122	DPA004B08	Resistor 200 ohms 1/2W
R123	DPA004B03	Resistor 120 ohms 1/2W
R124	DPA004C15	Resistor 3. 9K 1/2W
R125	DPA005C01	Resistor 1K 1/2W
R126	Willrite Prod., Inc.	Resistor 100 ohms 1/2W ± 1% Type CMCS
R127	DPG007J09	Potentiometer 10K Taper U
R128	DPA004A11	Resistor 27 ohms 1/2W
R129	DPG007B09	Potentiometer 10K Taper A
R130	DPA006B11	Resistor 270 ohms 1W
R131	Allen Bradley	Potentiometer 500 ohms 1/4W ± 10% Type "R"

Schematic Symbol No.	Sperry Part No.	Description
R132	DPA005D01	Resistor 10K 1/2W
R133	DPA005F01	Resistor 1Meg 1/2W
R134	DPA005D01	Resistor 10K 1/2W
R135	DPA006E05	Resistor 150K 1W
R136	DPA008E09	Resistor 220K 2W
R137	DPA005B05	Resistor 220 ohms 1/2W
R138	DPA005F01	Resistor 1 Meg 1/2W
R139	DPA005Do1	Resistor 10K 1/2W
R140	DPA006E18	Resistor 510K 1W
R141	DPA004D11	Resistor 27K 1/2W
R142	Not Used	
R143	DPA007C01	Resistor 10K 1W
R144	Willrite Prod., Inc.	Resistor 40 ohms 1/2W ±1% Type CMCS
R145	DPA006E18	Resistor 510K 1W
R146	DPA004B13	Resistor 330 ohms 1/2W
L101	50A2303	Amplifier Coil Assembly
L102	50A2584	Amplifier Coil Assembly
L103	50A2303	Amplifier Coil Assembly
L104	50A2303	Amplifier Coil Assembly
L105	50B764	Pulse Coil
L106	50B765	Pulse Coil
L107	50B766	Pulse Coil
L108	C.T.C.	RF Choke 150uh X20829
V101	6U8A	Tube
V102	VC1258	Tube
V103	6DK6	Tube
V104	6DK6	Tube
V105	6DK6	Tube
V106	6DK6	Tube
S101	50B768	Switch and Coil Assembly
	50B825	Switch Section
S102	Stackpole	Switch, 3 position maintained Type SS-31
S103	Stackpole	Switch, DP-DT maintained Type SS-33
T101	50B755	Transformer
K101	Amperite	Relay 6N030T
Q101	2N585	Transistor
Q102	2N585	Transistor
J101	CQC017P01	Plug
J102	Gremar Mfg. Co.	Receptacle 6804
J103	Gremar Mfg. Co.	Receptacle 6804
	Zierick	Terminal, 3/8 hole #334
	Tektronix	Sleeve #861-008
	Tektronix	Terminal Strip, 3 notch #124-092
	Tektronix	Terminal Strip, 5 notch #124-093
	Tektronix	Terminal Strip, 7 notch #124-094
	Tektronix	Terminal Strip, 11 notch #124-106
	Southco	Fastener #48-10-102-10
	DTB019A01	Transistor Socket
	DTB013B03	Tube Socket
	DTB013A02	Tube Socket
	DTB014A02	Tube Socket
	DTB014B02	Tube Socket
	DTD003A02	Dial Knob
	DTD004A04	Knob
	50A2301	Knob

PULSER/RECEIVER UNIT 1N
Reference Schematic 50C529

Note: All components same as 5N except those listed below

Schematic Symbol No.	Sperry Part No.	Description
C109	Cornell Dubilier	Capacitor 25uf 25v NL15-25
C112	ARCO 6DP-1-332	Capacitor .0033uf ±10%
C116	DGB006B34	Capacitor 300pf
C118	Cornell Dubilier	Capacitor .004uf 600v DPMS16D4
C123	Elmenco	Capacitor 1500uuf 500v CM20E152
C126	DQB006B48	Capacitor 1200uuf 500v
C127	Elmenco	Capacitor 620uuf 500v CM20E621
C129	DQB006B48	Capacitor 1200uuf 500v
C130	Elmenco	Capacitor 620uuf 500v CM20E621
C131	Cornell Dubilier	Capacitor 2 x .01uf 600v BYD6DS1
C132	Sprague	Capacitor .005uf 50v 125L-D50
C133	DQJ004A26	Capacitor 47uuf 600v
C134	DQB006B32	Capacitor 240uuf 500v
C135	DQB006B32	Capacitor 240uuf 500v
C136	DQB006B21	Capacitor 82uuf 500v
C137	DQB006B30	Capacitor 200uuf 500v
C138	DQB006B37	Capacitor 390uuf 500v
C139	DQB006B34	Capacitor 300pf 500v
C140	DQB006B27	Capacitor 150uuf 500v
C141	DQB006B18	Capacitor 62pf 500v
R119	DPA005D01	Resistor 10K 1/2W
R122	DPA004B08	Resistor 200 ohms 1/2W
R126	DPA004B02	Resistor 100 ohms 1/2W
R136	DPA008E06	Resistor 100K 2W
R147	DQG007J09	Potentiometer 10K Taper U
R148		Resistor 15 ohms 1/2W
L101	50B927	Amplifier Coil Assembly
L102	50B927	Amplifier Coil Assembly
L103	50B986	Amplifier Coil Assembly
L104	50B986	Amplifier Coil Assembly
L105	50B967	Pulse Coil
L106	50B824	Pulse Coil
L107	50B764	Pulse Coil
	C. T. C.	RF Choke 330uh X2082-11

PULSER/RECEIVER UNIT 2.25N
Reference Schematic 50C391

Note: All components same as 5N except those listed below.

C107	DQG001B05	Capacitor .1uf
C108	Cornell Dubilier	Capacitor 2 x .01 600v DYD6DS1
C112	ARCO 6DP-1-332	Capacitor .0033uf ±10%
C118	Cornell Dubilier	Capacitor .004uf 1600v DPMS16D4
C126	DQB005B34	Capacitor 200uuf
C127	DQB002B32	Capacitor 4700uuf
C128	DQG005A02	Capacitor .01uf 200v
C129	DQB005B34	Capacitor 200uuf
C130	DQB005B34	Capacitor 200uuf
C131	Cornell Dubilier	Capacitor 2 x .01uf 600v BYD6DS1
C132	Sprague	Capacitor .01uf 50v 125L-S10
C133	DQJ004A26	Capacitor 47uuf 600v
C135	DQG005A02	Capacitor .01uf
R122	DPA004B09	Resistor 220 ohms 1/2W
R147	DPA004B13	Resistor 330 ohms 1/2W
L102	50A2585	Amplifier Coil Assembly
L105	50B824	Pulse Coil
L106	50B764	Pulse Coil
L107	50B765	Pulse Coil

PULSER/RECEIVER UNIT 10N
Reference Schematic 50C519

Note: All components same as 5N except those listed below.

Schematic Symbol No.	Sperry Part No.	Description
C109	DQB005C37	Capacitor 250uuf 500v
C111	Sprague	Capacitor .005uf 50v TG-D50
C112	DQB005C04	Capacitor 5uuf 500v
C113	Sprague	Capacitor .005uf 50v TG-D50
C122	DQL002A10	Capacitor 25uf 25v
C123	DQB005C08	Capacitor 18uuf 500v
C124	Sprague	Capacitor .005uf 50v TG-D50
C131	Sprague	Capacitor .005uf 50v TG-D50
C132	DQG001B06	Capacitor .25uf 400v
C133	DQG001B06	Capacitor .25uf 400v
C134	DQG001B06	Capacitor .25uf 400v
CR102	Transitron	Diode SG555
R101	Willrite Prod., Inc	Resistor 2K 1/2W ± 10% Type CMCS
R114	DPA005E01	Resistor 100K 1/2W
R115	DPA006A08	Resistor 2K 1W ± 5%
R119	Willrite Prod., Inc.	Resistor 10K 1/2W Type CMCS
R124	Bourns	Potentiometer 1 Meg 2155-1-105
R125	DPA005C01	Resistor 1K 1/2W
R126	DPA004B19	Resistor 560 ohms 1/2W
R127	DPA004C01	Resistor 1K 1/2W
R128	DOA004C08	Resistor 2K 1/2W
R130	DPA006B07	Resistor 180 ohms 1W
R137	DPA005B10	Resistor 560 ohms 1/2W
R140	DPA005F02	Resistor 1.2 Meg 1/2W
R141	Bourns	Potentiometer 5K 273-1-502
R142	DPA004D11	Resistor 27K 1/2W
R143	DPA007D01	Resistor 10K 1W
R145	DPA005F02	Resistor 1.2 Meg 1/2W
R146	DPA004C01	Resistor 1K 1/2W
R147	DPG007J09	Potentiometer 10K Taper U
R148	DPA004B06	Resistor 160 ohms 1/2W
R149	DPA004B09	Resistor 220 ohms 1/2W
R150	DPA004C01	Resistor 1K 1/2W
R151	DPA005C01	Resistor 1K 1/2W
L101	50B908	Amplifier Coil Assembly 10mc
L102	50B908	Amplifier Coil Assembly 10mc
L103	50B895	Amplifier Coil Assembly
L104	50B895	Amplifier Coil Assembly
L105	50B896	Pulse Coil
L106	50B766	Pulse Coil
L107	50B765	Pulse Coil
L108	C.T.C.	RF Choke 2082-13
L109	C.T.C.	RF Choke 2082-13
L110	C.T.C.	RF Choke 2082-13
L111	C.T.C.	RF Choke 2082-13
S103	Stackpole	Switch Type SS-34
Q103	2N44	Transistor

PULSER/RECEIVER UNIT HFN
Reference Schematic 50C390

Schematic Symbol No.	Sperry Part No.	Description
C101	DQJ002A22	Capacitor 100uuf 600v
C102	Sprague	Capacitor .01uf 500v 19C241
C103	DQB005B18	Capacitor 47uuf 600v
C104	DQB005B31	Capacitor 150uuf 500v
C105	DQG002B04	Capacitor .05uf 400v
C106	DWL001A63	Capacitor 4uf 450v

Schematic Symbol No.	Sperry Part No.	Description
C107	DQL001A63	Capacitor 4uf 450v
C108	DQE001A07	Capacitor 7.5 - 100uuf 1200v
C109	Sprague	Capacitor .01uf 500v 19C241
C110	Sprague	Capacitor .01uf 500v 19C241
C111	Sprague	Capacitor .01uf 500v 19C241
C112	Sprague	Capacitor .01uf 500v 19C241
C113	Sprague	Capacitor .01uf 500v 19C241
C114	Sprague	Capacitor .01uf 500v 19C241
C115	Sprague	Capacitor .01uf 500v 19C241
C116	DQG001B05	Capacitor .1uf 500v
C117	Sprague	Capacitor .01uf 500v 19C241
C118	Sprague	Capacitor .01uf 500v 19C241
C119	DQB005B45	Capacitor 500uuf 500v
C120	DQE002A04	Capacitor .1uf 200v
C121	DQL001A18	Capacitor 10uf 25v
C122	DQG002B05	Capacitor .1uf 400v
C123	DQG002B05	Capacitor .1uf 400v
C124	DQB005B14	Capacitor 33uuf 500v
C125	Sprague	Capacitor .01uf 500v 19C241
C126	Sprague	Capacitor .01uf 500v 19C241
C127	Sprague	Capacitor .01uf 500v 19C241
C128	DQE002A04	Capacitor .1uf 200v
C129	DQE002A04	Capacitor .1uf 200v
C130	Not used	
C131	Sprague	Capacitor .01uf 500v 19C241
C132	Sprague	Capacitor 10uf 25vdc TE1204
CR101	Transitron	Diode SG555
CR102	Transitron	Diode SG555
CR103	Solitron Devices, Inc.	Diode CER-72
CR104	Solitron Devices, Inc.	Diode CER-72
CR105	Solitron Devices, Inc.	Diode CER-72
CR106	Solitron Devices, Inc.	Diode CER-72
R101	DPA005D01	Resistor 10K 1/2W
R102	DPA005F01	Resistor 1 Meg 1/2W
R103	DPA005D01	Resistor 10K 1/2W
R104	DPA006E05	Resistor 150K 1W
R105	DPA005F01	Resistor 1 Meg 1/2W
R106	DPA005D01	Resistor 10K 1/2W
R107	DPA008E13	Resistor 330K 2W
R108	DPA006E18	Resistor 510K 1W
R109	DPA006E18	Resistor 510K 1W
R110	DPG007B11	Potentiometer 2.5K
R111	DPA004B08	Resistor 200 ohms 1/2W
R112	DPA005D01	Resistor 10K 1/2W
R113	DPA005A02	Resistor 12 ohms 1/2W
R114	DPA004C03	Resistor 1.2K 1/2W
R115	DPA005D01	Resistor 10K 1/2W
R116	DPA005B09	Resistor 470 ohms 1/2W
R117	DPA005A02	Resistor 12 ohms 1/2W
R118	DPA005A05	Resistor 22 ohms 1/2W
R119	50A2734	Potentiometer 1K
R120	DPA005D01	Resistor 10K 1/2W
R121	DPA005B09	Resistor 470 ohms 1/2W
R122	DPA004C07	Resistor 1.8K 1/2W
R123	DPA005D01	Resistor 10K 1/2W
R124	DPA004B03	Resistor 120 ohms 1/2W
R125	DPA006B17	Resistor 470 ohms 1W
R126	DPA004C17	Resistor 4.7K 1/2W
R127	DPA005D01	Resistor 10K 1/2W
R128	DPA004B03	Resistor 120 ohms 1/2W
R129	DPA004C09	Resistor 2.2K 1/2W
R130	Bourns	Potentiometer 100 ohms 273-1-101
R131	DPA005D12	Resistor 82K 1/2W
R132	DPA004A19	Resistor 56 ohms 1/2W
R133	DPA005C05	Resistor 2.2K 1/2W
R135	DPA004A19	Resistor 56 ohms 1/2W
R136	DPA005B09	Resistor 470 ohms 1/2W
R137	DPG007H10	Potentiometer 5K

Schematic Symbol No.	Sperry Part No.	Description
R138	Bourns	Potentiometer 5K 273-1-502
R139	DPA004C08	Resistor 2K 1/2W
R140	DPA004B15	Resistor 390 ohms 1/2W
R141	Not used	
R142	DPA009C11	Resistor 6.8K 2W
R143	DPA007A08	Resistor 39 ohms 1W
L101	DRA003A05	Choke 33uh
L102	DRA003A05	Choke 33uh
L103	DRA003A05	Choke 33uh
V101	6U8A	Tube
V102	VC125B	Tube
V103	Raytheon	Tube CK6688
V104	Raytheon	Tube CK6688
V105	6DK6	Tube
V106	6DK6	Tube
S101	Stackpole	Switch Type SS-34
T101	50B755	Transformer
K101	Amperite	Relay 6N030T
Q101	2N502	Transistor
Q102	2N502	Transistor
J101	CQC017P01	Plug
J102	Gremar Mfg. Co.	Receptacle 6804
J103	Gremar Mfg. Co.	Receptacle 6804
J104	Elco	Connector 5009-13-2-5-3/32
J105	Elco	Connector 5009-13-2-5-3/32
	Tektronix	Sleeve #361-008
	Tektronix	Terminal Strip #124-092
	Tektronix	Terminal Strip #124-094
	Tektronix	Terminal Strip #124-106
	Southco	Fastener #48-10-102-10
	Southco	Side Rail Spring #90-0-5931-11
	DTB019A01	Transistor Socket
	DTB013A02	Tube Socket
	DTB013B03	Tube Socket
	DTB014A02	Tube Socket
	DTB014B02	Tube Socket
	DTB003A02	Dial Knob
	DTB004A04	Knob
	50A2301	Knob
	10mc Plug-In Board:	
	50A2827	Bracket Flag 10mc
	Elmenco	Capacitor .001uf 500v 3CCD-102
	DQB005B05	Capacitor 10uuf 500v
L104	50B957	Coil - Pulser - 10mc
L105	50B963	Coil - RF - 10mc
L106	50B963	Coil - RF - 10mc
L107	50B963	Coil - RF - 10mc
L108	50B960	Coil - RF - 10mc
	15mc Plug-In Board:	
	50A2828	Bracket Flag 15mc
	Elmenco	Capacitor .001uf 3000v 3CCD-102
L104	50B958	Coil - Pulser - 15mc
L105	50B964	Coil - RF - 15mc
L106	50B964	Coil - RF - 15mc
L107	50B964	Coil - RF - 15mc
L108	50B961	Coil - RF - 15mc

Schematic Symbol No.	Sperry Part No.	Description
	25mc Plug-In Board:	
	50A2829	Bracket Flag 25mc
	Elmenco	Capacitor .001uf 3000v 3CCD-102
L104	50B959	Coil - Pulser - 25mc
L105	50B965	Coil - RF - 25mc
L106	50B965	Coil - RF - 25mc
L107	50B966	Coil - RF - 25mc
L108	50B962	Coil - RF - 25mc

PULSER/RECEIVER UNIT 5NRF

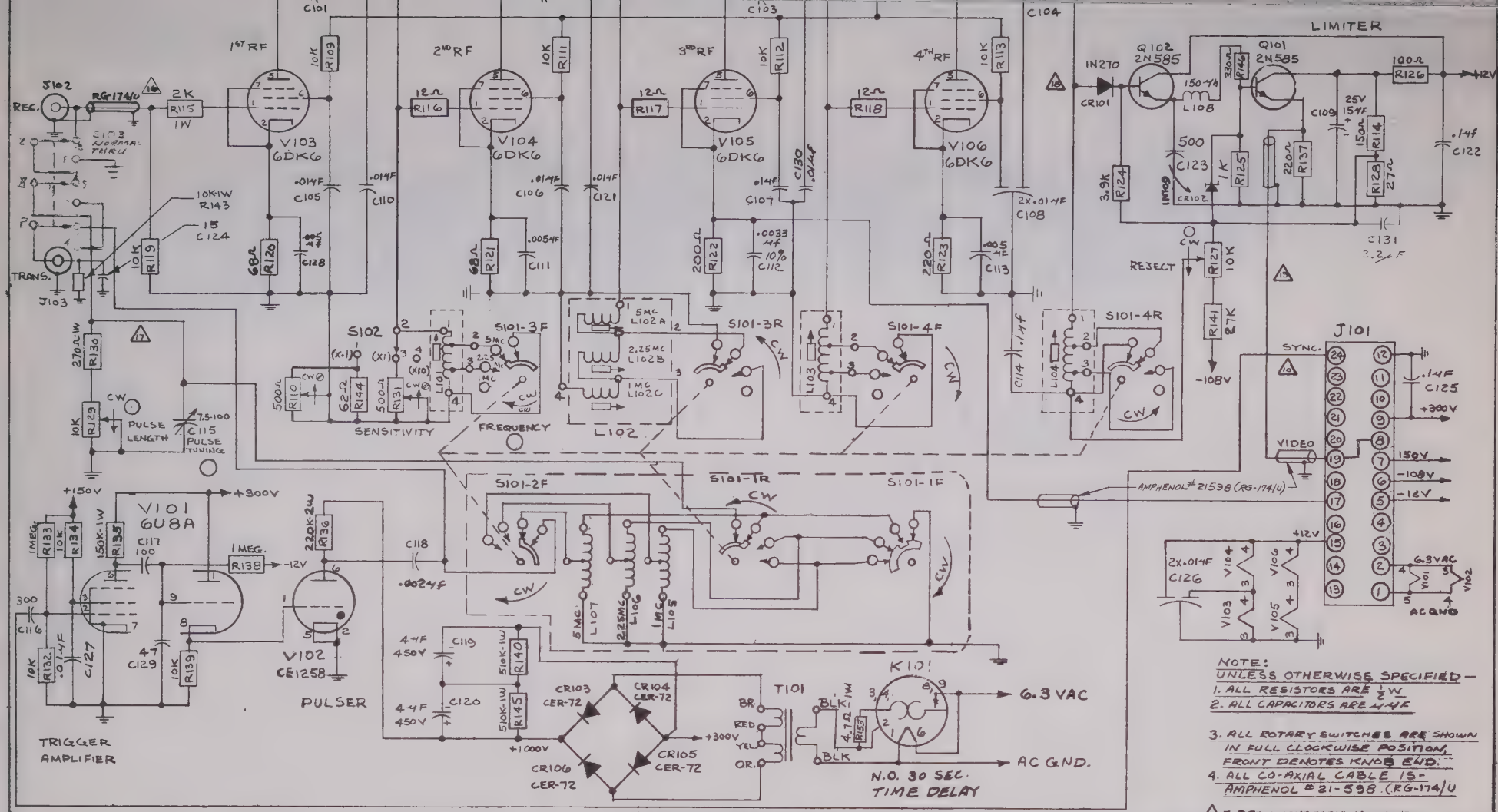
Reference Schematic 50C703

Schematic Symbol No.	Sperry Part No.	Description
C101	DQG002A04	Capacitor .1uuf 200v
C102	Same as C101	
C103	DQJ002A37	Capacitor 500uuf 600v
C105	DQG005A02	Capacitor .01uf 200v
C106	Same as C105	
C107	Same as C101	
C108	Cornell Dubilier	Capacitor 2 x .01uf 600v BYD6DS1
C110	Same as C105	
C111	Sprague	Capacitor .005uf 50v 125L-D50
C112	ARCO	Capacitor 3300uuf 600v 10% 6DP1-332
C113	Same as C111	
C115	DQE001A07	Capacitor 7.5-100uuf 1200v
C116	DQJ002A22	Capacitor 100uuf 600v
C117	Same as C116	
C118	Cornell Dubilier	Capacitor .002uf 1600v DPMS16D2
C119	DQL001A63	Capacitor 4uf 450v
C120	Same as C119	
C121	Same as C105	
C122	Sprague	Capacitor .1uf 25v 5C7
C124	Sprague	Capacitor 15uuf 5GA-Q15
C126	Same as C122	
C127	Same as C105	
C128	Same as C111	
C129	DQJ004A26	Capacitor 47uuf 600v
C130	Same as C105	
C131	Same as C122	
C132	Same as C122	
C133	Same as C122	
C135	Sprague	Capacitor .022uf 500v 5GAB-S22
C136	Sprague	Capacitor 10uf 150v TVA1406
CR103	Solitron Devices, Inc.	Diode CER-72
CR104	Same as CR103	
CR105	Same as CR103	
CR106	Same as CR103	
J101	CQC017P01	Plug
J102	Gremar Mfg. Co.	Receptacle
J103	Same as J102	
K101	Amperite	Relay 6N030T
L101	50A2303	Amplifier Coil Assembly
L102	50A2584	Amplifier Coil Assembly
L102A	C. T. C.	Coil X2060-6
L102B	C. T. C.	Coil X2060-8
L102C	C. T. C.	Coil X2060-10
L103	Same as L101	
L104	50A3153	Amplifier Coil Assembly
L104A	C. T. C.	Coil X2060-5
L104B	C. T. C.	Coil X2060-8
L104C	C. T. C.	Coil X2060-10
L105	50B764	Pulse Coil
L106	50B765	Pulse Coil
L107	50B766	Pulse Coil

Schematic Symbol No.	Sperry Part No.	Description
R101	Willrite Prod., Inc.	Resistor 2K 1/2W ± 1% Type CMCS
R102	DPA005B09	Resistor 470 ohms 1/2W 5%
R103	Same as R102	
R104	DPA009B09	Resistor 470 ohms 2W
R105	50A2478	Potentiometer 2.5K
R106	DPA004C12	Resistor 3K 1/2W 5%
R107	DPA004C09	Resistor 2.2K 1/2W 5%
R108	DPA005D01	Resistor 10K 1/2W
R109	Same as R108	
R110	Allen-Bradley	Potentiometer Type R
R111	Same as R108	
R112	Same as R108	
R115	DPA006C08	Resistor 2K 1W 5%
R116	DPA005A02	Resistor 12 ohms 1/2W
R117	Same as R116	
R118	Same as R116	
R119	Willrite Prod., Inc.	Resistor 10K 1/2W ± 1% Type CMCS
R120	DPA004A21	Resistor 68 ohms 1/2W 5%
R121	Same as R120	
R122	DPA004B08	Resistor 200 ohms 1/2W
R123	DPA004B03	Resistor 120 ohms 1/2W 5%
R127	DPG007C07	Potentiometer 50K Taper A
R129	DPG007B09	Potentiometer 10K Taper A
R130	DPA006B11	Resistor 270 ohms 1W 5%
R131	Same as R110	
R132	Same as R108	
R133	DPA005F01	Resistor 1 Meg 1/2W
R134	Same as R108	
R135	DPA006E05	Resistor 150K 1W
R136	DPA008E09	Resistor 220K 2W
R138	Same as R133	
R139	Same as R108	
R140	DPA006E18	Resistor 510K 1W
R143	DPA007D01	Resistor 10K 1W ±10%
R144	Willrite Prod. Inc.	Resistor 40 ohms 1/2W ± 1% Type CMCS
R145	Same as R140	
R149	DPA007B09	Resistor 470 ohms 1W ± 5%
S101	50B757	Switch
S102	Stackpole	Switch SS-31
S103	Stackpole	Switch SS-33 DP-DT
T101	50B755	Transformer
V101	6U8A	Tube
V102	VC1258	Tube
V103	6DK6	Tube
V104	Same as V103	
V105	Same as V103	
V106	Same as V103	
	DTD003A02	Dial Knob
	DTD004A04	Knob
	Tektronix	Sleeve 361-008
	Tektronix	Terminal Strip 124-092
	Tektronix	Terminal Strip 124-094
	Tektronix	Terminal Strip 124-106
	DTB013B03	Tube Socket
	DTB013A02	Tube Socket
	DTB014A02	Tube Socket
	DTB014B02	Tube Socket

R. F. REJECT AND DRIVE P. C. BOARD
COMPONENT ASSEMBLY
Reference Schematic 50C703

Schematic Symbol No.	Sperry Part No.	Description
C104	Sprague	Capacitor . 1uf 25v 5C7
C109	Sprague	Capacitor . 1uf 500v 5HK-P10
C114	Same as C109	
C122	Same as C104	
C123	Same as C104	
C125	Same as C104	
C137	Centralab	Capacitor . 01uf 1000v DD103
C138	Sprague	Capacitor . 1uf 25 vdc 5C7
CR101	Transitron	Diode S555G
CR102	Same as CR101	
L108	C. T. C.	R. F. Choke 1uh 10% X2082-14
L109	Same as L108	
Q101	2N1308	Transistor
Q102	2N1309	Transistor
R113	DPA004C10	Resistor 2. 4K 1/2W 5%
R114	DPA004A24	Resistor 91 ohms 1/2W 5%
R124	DPA004B11	Resistor 270 ohms 1/2W 5%
R125	DPA004C22	Resistor 7. 5K 1/2W 5%
R126	Same as R114	
R128	DPA004C20	Resistor 6. 2K 1/2W 5%
R137	Same as R125	
R141		Potentiometer 2. 5K
R142	DPA004B01	Resistor 100 ohms 1/2W 5%
R146	Same as R125	
R147	DPA004C10	Resistor 2. 4K 1/2W 5%
R148	DPA006B12	Resistor 300 ohms 1W 5%
	ELCO	Transistor Socket 3303



NOTE:
UNLESS OTHERWISE SPECIFIED —
1. ALL RESISTORS ARE ½ W.
2. ALL CAPACITORS ARE .1 μF
3. ALL ROTARY SWITCHES ARE SHOWN IN FULL CLOCKWISE POSITION. FRONT DENOTES KNOB END.
4. ALL CO-AXIAL CABLE IS — AMPHENOL # 21-598 (RG-174/U

△ = REF. WAVEFORM NUMBER.

LTR.	E.C.N. NO.	DATE	CHK.
AA	7215	10-12-64	TH
ZZ	7146	7-14-64	TH
YY	6799	5-5-64	TH
X	6722	3-17-64	DM
W	6697	1-9-64	TH
V	6662	9-26-63	MM
U	6620	9-16-63	TH
T	6561	5-18-63	TH
S	6375	1-7-63	TH
R	6239	9-26-62	EM
P	6091	9-10-62	TH
N	5877	7-17-62	TH
M	5726	8-18-61	DM
L	5471	1-24-61	DM
K	5438	1-4-61	MM
J	5425	12-20-60	MM
H	5379	11-16-60	MM
F	5319	10-24-60	MM
E	5265	9-26-60	MM
D	5237	9-9-60	MM
C	5171	7-21-60	TH
B	5153	7-1-60	TH
A	5110	6-13-60	TH

CHANGE LTR. — CHANGE — E. C. N. NO. — DATE — DRAFTSMAN — CHECKER — ENG'S APPR. — ENG. — REF. — TIMES USED

SCALE — EXCEPT AS NOTED — DEC. ± — FRAC. ± — ANGLES ± — MACH. ✓

50E524 REF. ASS'Y. NO.

MAT. OR P. SPEC. — FINISH

SPERRY PRODUCTS, INC. Danbury, Connecticut

SCHEMATIC · PULSER/RECEIVER SW

UM REFLECTOSCOPE

Sperry 50C361

R.R.S. 4-11-66

DRAWN BY RRS 5-18-66 — CHECKED BY — APPROVED BY

TPC 705

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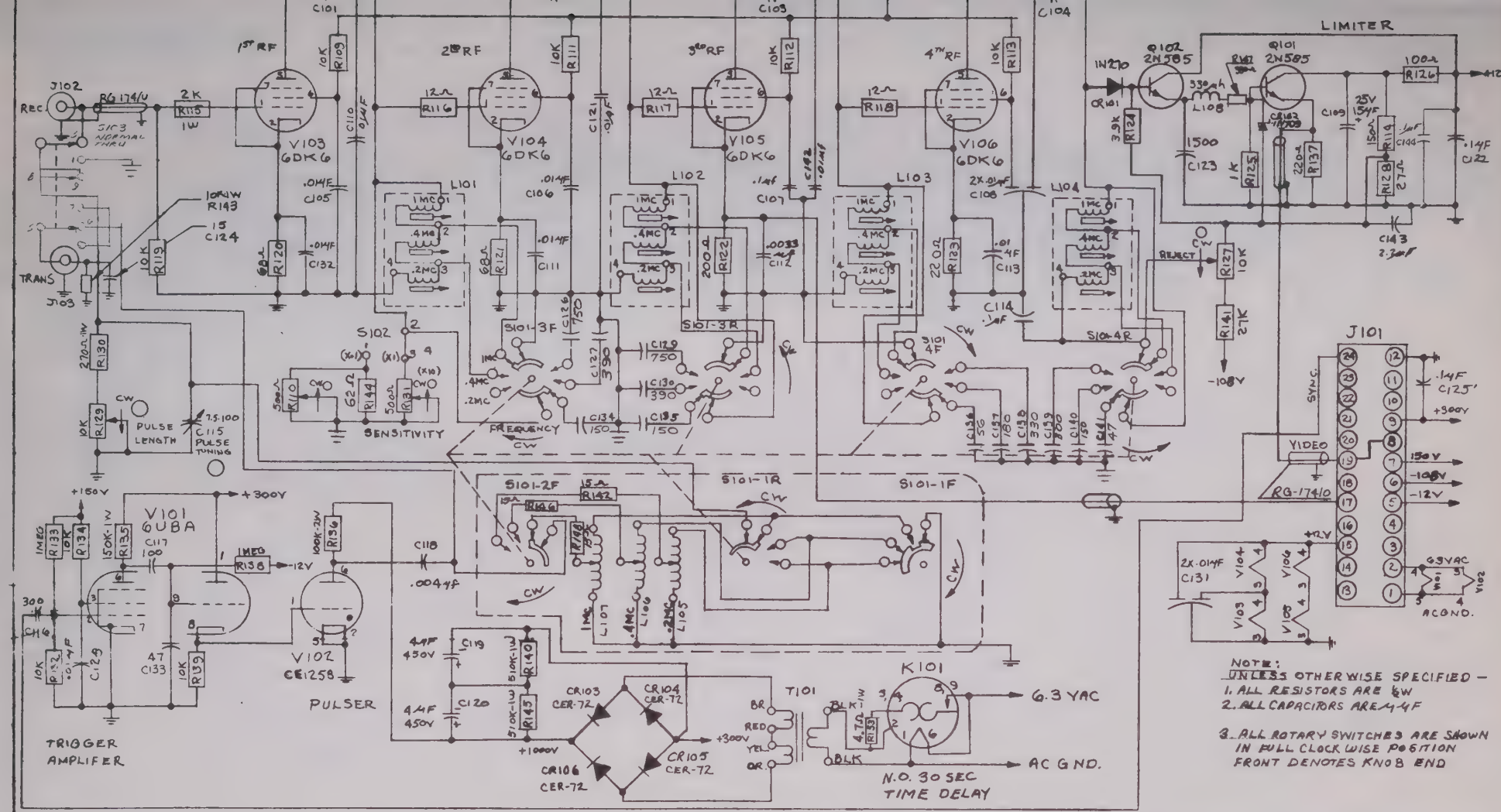

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LTR	DATE	BY	CHK	APP	DESCRIPTION
P	7/2/65				
O	6833	6/30/64			
N	6799	7/14/64			
M	6772	6/10/64			
L	6750	5-5-64			
K	6697	2/26/64			
J	6667	1-9-64			
H	6630	10-8-63			
F	6620	9-26-63			
E	6561	8-28-63			
D	6547	8-16-63			
C	6378	7-3-63			
B	6305	10-16-62			
A	6236	9-5-62			

50ES84

SPERRY PRODUCTS, INC.
Danbury, Connecticut

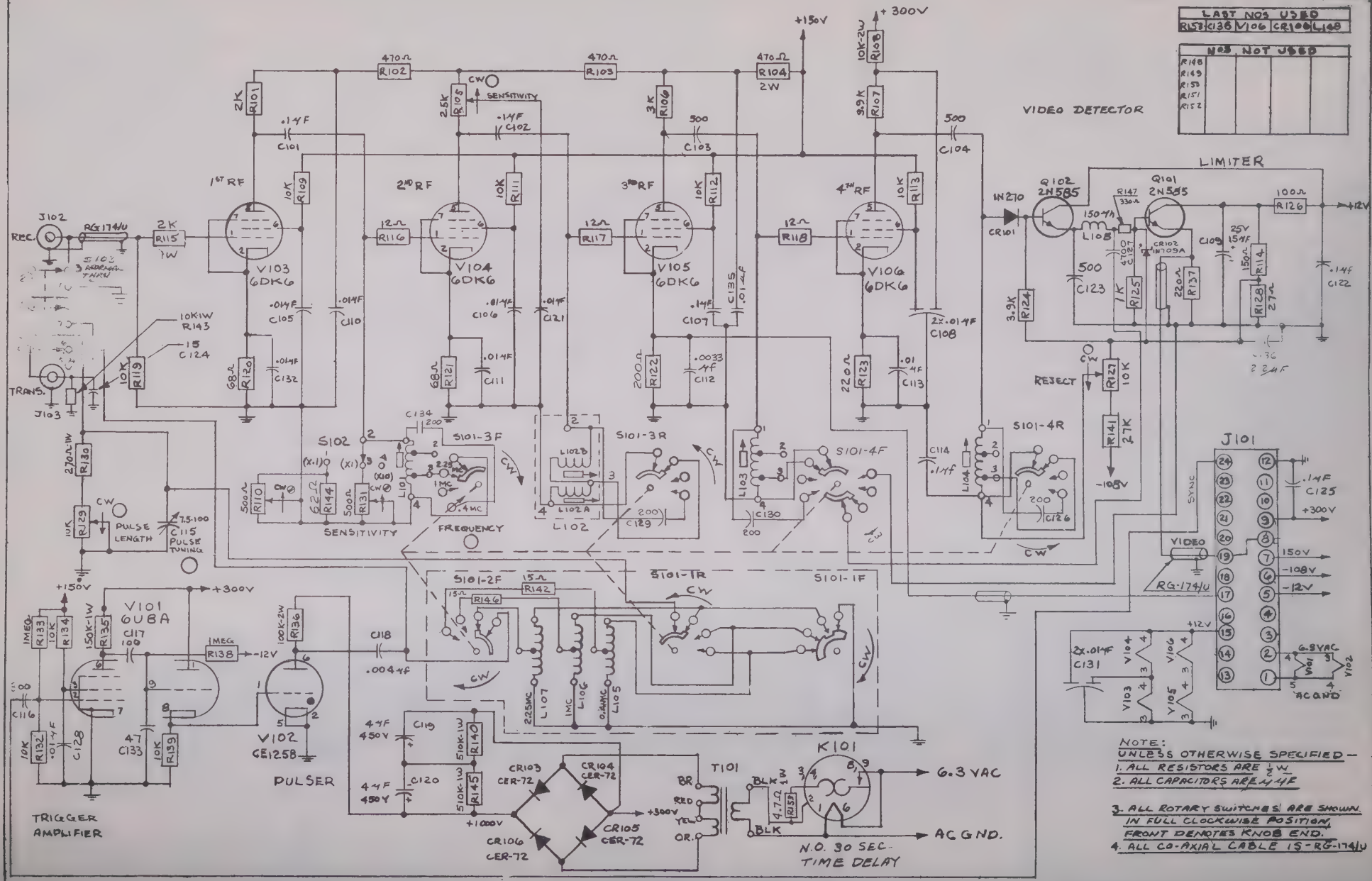
SCHEMATIC - PULSER/RECEIVER 1N
UM REFLECTOSCOPE

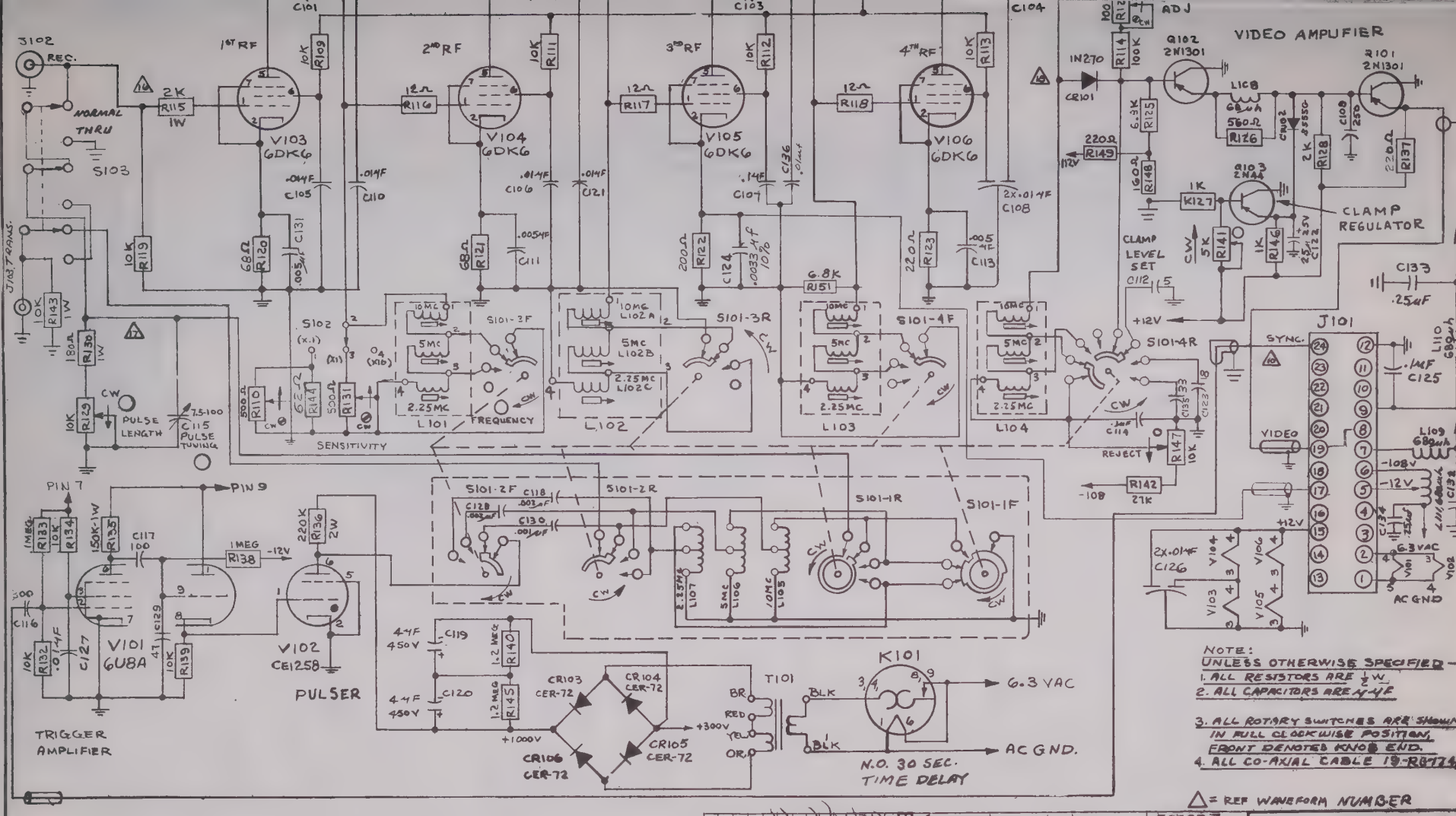
50C529

GC - 8-7-62

Mfg Iss: 2-25-65
Eng 10-21-65

50C529


LAST NOS USED
R158 C136 V106 CR106 L108
NOS NOT USED
R148
R149
R150
R151
R152
VIDEO DETECTOR
LIMITER
1ST RF
2ND RF
3RD RF
4TH RF
V103 6DK6
V104 6DK6
V105 6DK6
V106 6DK6
Q102 2N585
Q101 2N585
IN270
CR101
CR102 1N709A
J102
REC.
RG174/U
J103
TRANS.
S102
S101-3F
S101-3R
S101-4F
S101-4R
S101-2F
S101-TR
S101-1F
FREQUENCY
SENSITIVITY
PULSE LENGTH
PULSE TUNING
REJECT
J101
VIDEO
SYNC
V101 6U8A
V102 CE125B
PULSER
TRIGGER AMPLIFIER
T101
K101
N.O. 30 SEC. TIME DELAY
CR103 CER-72
CR104 CER-72
CR105 CER-72
CR106 CER-72
+150V
+300V
-108V
-12V
+12V
6.3 VAC
AC GND.
NOTE:
UNLESS OTHERWISE SPECIFIED —
1. ALL RESISTORS ARE 1/2 W.
2. ALL CAPACITORS ARE μF
3. ALL ROTARY SWITCHES ARE SHOWN IN FULL CLOCKWISE POSITION. FRONT DENOTES KNOB END.
4. ALL CO-AXIAL CABLE IS RG-174/U



NOTE:
UNLESS OTHERWISE SPECIFIED —
1. ALL RESISTORS ARE ½ W
2. ALL CAPACITORS ARE μF
3. ALL ROTARY SWITCHES ARE SHOWN IN FULL CLOCKWISE POSITION, FRONT DENOTES KNOB END.
4. ALL CO-AXIAL CABLE 19-RB174/U

△ = REF WAVEFORM NUMBER

STR	ECN NO.	DATE	CHK
M	6888	12-4-64	
L	6772	6-10-64	
K	6750	2-18-64	
J	6697	2-4-64	
H	6686	12-9-63	
G	6667	11-7-63	
F	6545	5-29-63	
E	6466	2-22-63	
D	6376	1-7-63	
C	6209	8-21-62	EXL
B	5970	4-10-62	
A			

CHANGE LTR.
CHANGE
E. C. N. NO.
DATE
DRAFTSMAN
CHECKER 50E533 REF
ENG'S APPR.

SCALE —
EXCEPT AS NOTED
DEC. ± —
FRAC. ± —
ANGLES ± —
MACH. ✓
50E533
MAT. OR P. SPEC.

SPERRY PRODUCTS, INC.
Danbury, Connecticut
SCHEMATIC-PULSER/RECEIVER 10KW
UM REFLECTOSCOPE
50C519
3/18 7-25-61
6151

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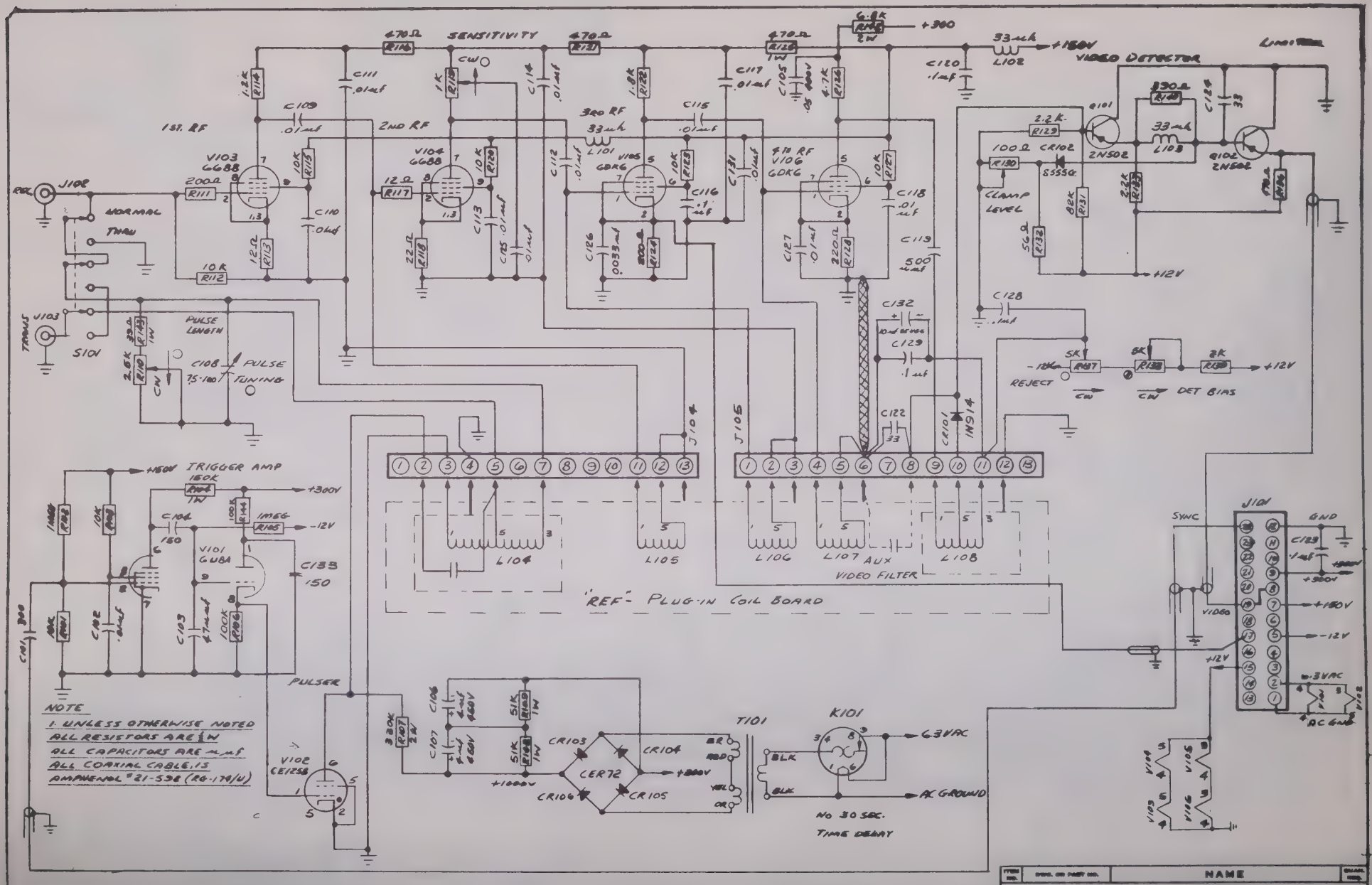
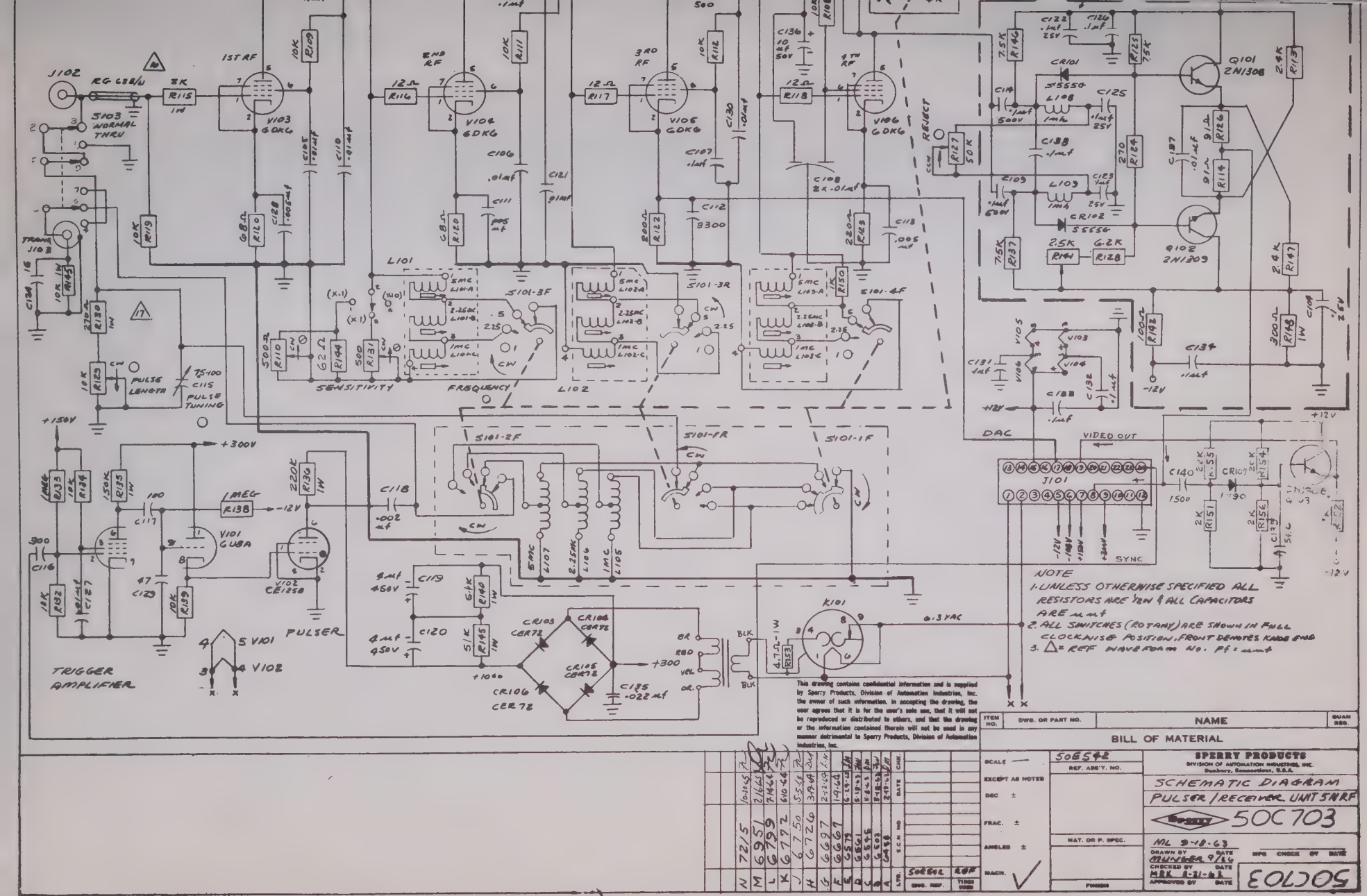

SENSITIVITY
1ST. RF
2ND RF
3RD RF
4TH RF
V103 6688
V104 6688
V105 6DK6
V106 6DK6
NORMAL
TWIN
PULSE LENGTH
PULSE TUNING
VIDEO DETECTOR
Q101 2N502
Q102 2N502
CLAMP LEVEL
REJECT
DET BIAS
+12V
+300
+180V
J102
J103
J104
J105
J101
S101
TRIGGER AMP
V101 6U8A
V102 CE1258
PULSER
L104
L105
L106
L107 AUX
L108
VIDEO FILTER
"REF" PLUG-IN COIL BOARD
SYNC
GND
VIDEO
-12V
6.3VAC
AC GND
T101
K101
CR101 IN914
CR103
CR104
CR105
CR106
CER72
+1000V
6.3VAC
AC GROUND
No 30 SEC.
TIME DELAY
NOTE
1. UNLESS OTHERWISE NOTED
ALL RESISTORS ARE ½W
ALL CAPACITORS ARE μμf
ALL COAXIAL CABLE, 13
AMPHENOL "21-538 (RG-174/U)
NAME
BILL OF MATERIAL



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ITEM NO.	DWG. OR PART NO.	NAME	QUAN REQ.

BILL OF MATERIAL

LTR.	E.C.N. NO.	DATE	CHK.
N	7215	10-28-65	RL
M	6951	2-16-65	RL
L	6799	7-14-64	RL
K	6772	6-19-64	RL
J	6750	5-5-64	RL
H	6726	3-9-64	RL
G	6697	2-12-64	RL
F	6679	1-9-64	RL
E	6519	6-18-63	RL
D	6461	5-15-63	RL
C	6455	5-8-63	RL
B	6402	4-8-63	RL
A	6398	2-21-63	RL

SCALE	—	506542
EXCEPT AS NOTED		REF. ASS'Y. NO.
DEC	±	
FRAC.	±	
ANGLES	±	MAT. OR P. SPEC.
MACH.	✓	FINISH

SPERRY PRODUCTS
DIVISION OF AUTOMATION INDUSTRIES, INC.
Danbury, Connecticut, U.S.A.

SCHEMATIC DIAGRAM
PULSER / RECEIVER UNIT S-BAND

506703

DRAWN BY	DATE	MFG CHECK BY DATE
MUNGER	9/16	
CHECKED BY	DATE	
MRK	8-21-63	
APPROVED BY	DATE	

NRL 9-18-63

506703

SECTION VII

DISTANCE AMPLITUDE CORRECTION (DAC) UNIT

SCRIPTION

GENERAL

The primary function of the DAC (Distance Amplitude Correction) unit is to correct for the "near field" and "far field" response characteristic which is typical of ultrasonic tests. The "near field" zone starts at the surface of a test piece and extends to a limit determined by search unit size, type and frequency. Within this zone the amplitude of signals reflected from a given size defect (such as a #5 flat bottomed hole) will increase as a function of distance from the surface. From the "near field" limit on (far field), signals from a #5 hole will continuously decrease due to attenuation in the material under test. A plot of typical signal response is shown in Figure 7-1

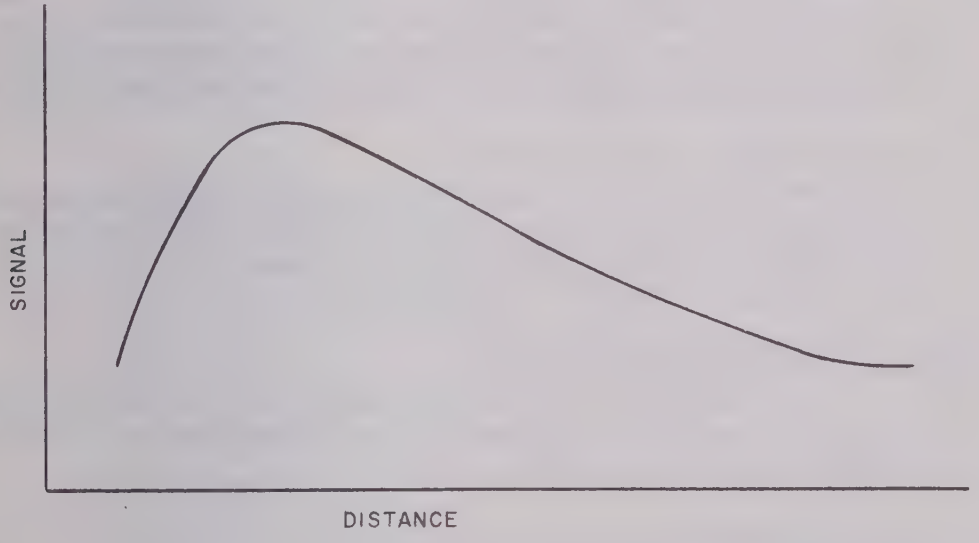


Figure 7-1

The DAC unit is designed to provide a correction for this response such that received signals will be independent of distance from surface, and a #5 hole will appear on the UM display at a constant amplitude regardless of its depth. Therefore, it is possible, for example, to set up for a given reference defect at 3 inches and know that any signal which equals this reference will be equal in effective area. The correction is effected by generating an electrical wave shape which approximates the actual distance amplitude wave, and applying it to the Pulser/Receiver to change its sensitivity in a correcting manner. The wave shape is displayed on the cathode ray tube for convenience in setting up. The practical range of correction is 10:1. This range and the shapes which can be generated will

accommodate the majority of practical test requirements.

In addition to the distance amplitude correction, the DAC can also provide a gate pulse to control the amplitude of signals in a specific area independent of other signals. This might be used, for example, to reduce back echo signals to a level equivalent to defect signals, so its amplitude can be monitored.

The operation of the DAC can be synchronized to either the main pulse or the first echo.

The DAC unit consists of the following major components:

a. Timing 50C697
Printed circuit board containing circuitry for generation of the DAC waveform and the gate pulse.

b. Compensating Amplifier 50C698
Printed circuit board containing circuitry for establishing the necessary relation between the DAC waveform that is displayed an the DAC waveform that is used to control the receiver sensitivity.

c. Front and Rear Panel Assembly
Structural portion of DAC unit which accepts the timing and compensating amplifier boards; containing the external controls on front panel and the connectors for interconnecting the DAC with the Special Function Cabinet in the rear.

2. MECHANICAL SPECIFICATIONS

The DAC unit plugs into the accessory slot of the UM 721 and is easily disconnected for servicing or interchange. The following front panel controls are provided:

a. Timing Controls
START (Pointer and vernier)
LENGTH (Pointer and vernier)

b. WAVE GENERATOR Controls
POSITIVE SLOPE Control
(1) UPPER (Black Knob)
(2) LOWER (Red Knob)
NEGATIVE SLOPE Control
(1) UPPER (Black Knob)
(2) LOWER (Red Knob)
AMPLITUDE (Black Knob)
CUT OFF (Red Knob)
FUNCTION (Two position slider switch)

c. SYNC (Two position slider switch)
d. MODE (Three position slider switch)

ELECTRICAL SPECIFICATIONS

All required power is obtained from the Display/Timer unit.

RATION

FUNCTION OF CONTROLS

TIMING CONTROLS

(1) START (Pointer) - Provides coarse positioning of the start of the DAC waveform or gate pulse.
(2) START (Vernier) - Provides fine positioning of the start of the DAC waveform or gate pulse.
(3) LENGTH (Pointer) - Provides coarse positioning of the peak of length of the DAC waveform or coarse adjustment of the gate pulse length.
(4) LENGTH (Venier) - Provides fine positioning of the peak of length of the DAC waveform or fine adjustment of the gate pulse length.

WAVE GENERATOR CONTROLS

(1) POSITIVE SLOPE-UPPER (Black knob) - Permits slope adjustment of the upper portion of the leading edge of the DAC waveform. Has no effect on the gate pulse.
(2) POSITIVE SLOPE-LOWER (Red knob) - Permits slope adjustment of the lower portion of the leading edge of the DAC waveform. Has no effect on the gate pulse.
(3) NEGATIVE SLOPE-UPPER (Black knob) - Permits slope adjustment of the upper portion of the lagging edge of the DAC waveform. Has no effect on the gate pulse.
(4) NEGATIVE SLOPE-LOWER (Red knob) - Permits slope adjustment of the lower portion of the lagging edge of the DAC waveform. Has no effect on the gate pulse.
(5) CUT OFF (Red knob) - Permits amplitude adjustment of the lower portion of the lagging edge of the DAC waveform. Has no effect on the gate pulse.
(6) AMPLITUDE (Black knob) - Permits amplitude adjustment of the DAC waveform and gate pulse.
(7) FUNCTION (Two position switch) - Permits selection of DAC output.

DAC (position) - the output of the DAC unit is a waveform suitable for correcting the near field and far field characteristics of a transducer.

PULSE (position) - the output of the DAC unit is a pulse whose position, duration and amplitude can be controlled. Such a

pulse can be used to reduce the receiver sensitivity corresponding to a specific region of a test specimen.

c. SYNC (2 position switch)
Permits selection of synchronizing pulse.

Main Pulse (position) - Synchronizes the DAC waveform with the start of sweep regardless of sweep settings.

I.F. (position) - Synchronizes the DAC to first echo pulse independent of sweep settings. A transigate is required to provide I.F. sync.

d. MODE (3 position switch)
This switch permits rapid determination of the DAC waveform.

Display (position) - the DAC waveform is displayed on the marker sweep. It has no effect on the receiver sensitivity. Thus a DAC waveform can be selected such that it matches the echo peaks.

On (position) - the DAC waveform is displayed on the marker sweep and at the same time the receiver sensitivity is affected in such a manner that the echo peaks are approximately equal in magnitude (at this point fine adjustment of the wave generator controls should equalize the echo peaks to within ±10% of a median value).

Off (position) - the DAC output is neither displayed nor does it have any effect on receiver sensitivity.

2. FAMILIARIZATION

a. SET-UP
(1) Assemble a search unit mounted to DAC test block, Number 50B1208, UM Reflectoscope with Special Function Cabinet. (Transigate not necessary unless I.F. mode of operation is desired).
(2) Check that the DAC unit is positioned and properly secured.
(3) Turn on the UM Reflectoscope. Set marker control to OFF position.
(4) Set the DAC unit Mode Switch to DISPLAY

NOTE: Always turn off the UM Reflectoscope when plugging the DAC unit in or out.

b. GENERAL
Manipulate the various DAC controls and observe their effect on the UM Reflectoscope presentation.

c. DETAIL

(1) Near field and far field correction.

Set the DAC Mode Switch to OFF position. By using the test block adjust the UM controls such that a pattern similar to Figure 7-2 is obtained.

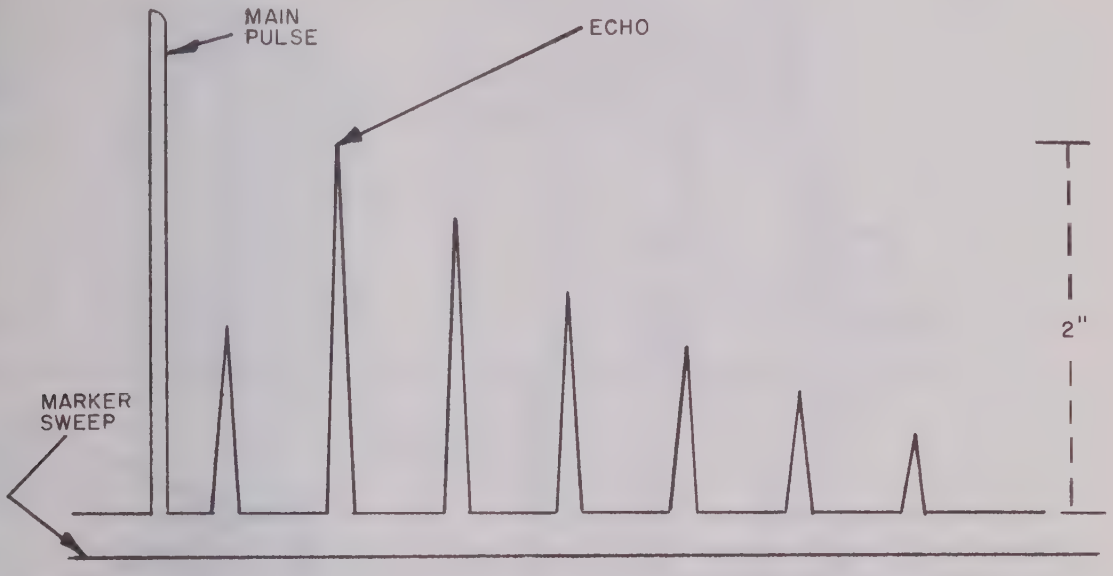


Figure 7-2

Set DAC Mode switch to DISPLAY position and the Function switch to PULSE position. Adjust the Timing controls such that a pattern similar to Figure 7-3 is obtained.

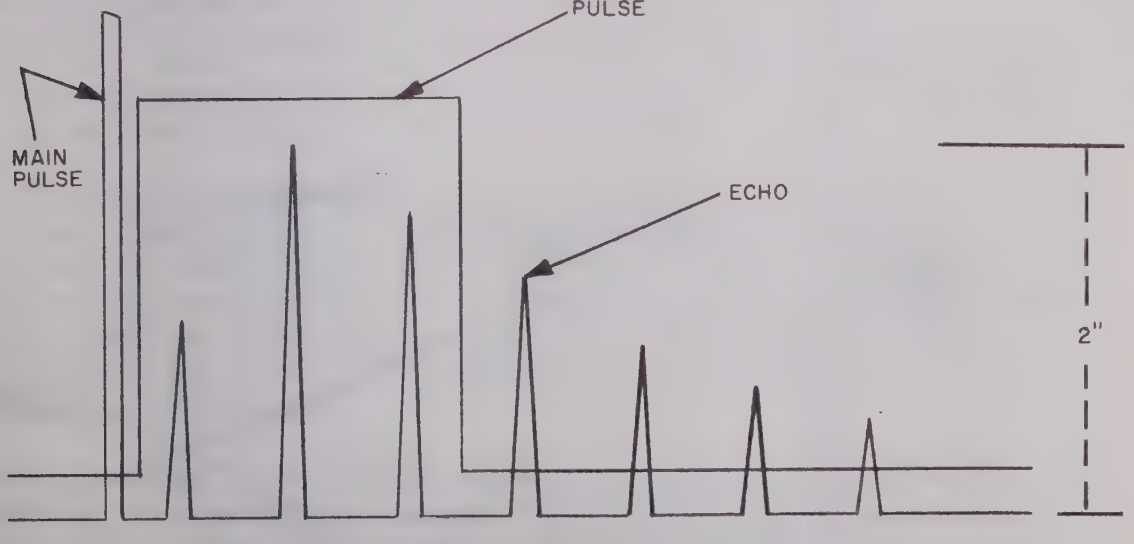


Figure 7-3

Set the Function switch to DAC position and adjust the Amplitu control such that the maximum amplitude of the DAC waveform is 2". Now adjust the DAC controls in the following order unti a pattern similar to Figure 7-4 is obtained:

a. Lower positive slope.
b. Upper positive slope
c. Start and length
d. Upper negative slope
e. Lower negative slope

Figure 7-4

Set the DAC Mode switch to ON and adjust the receiver sensitivity until the desired echo amplitude level is reached. If the echo amplitude is not uniform readjust slightly the START control, until a pattern similar to Figure 7-5 b is obtained.

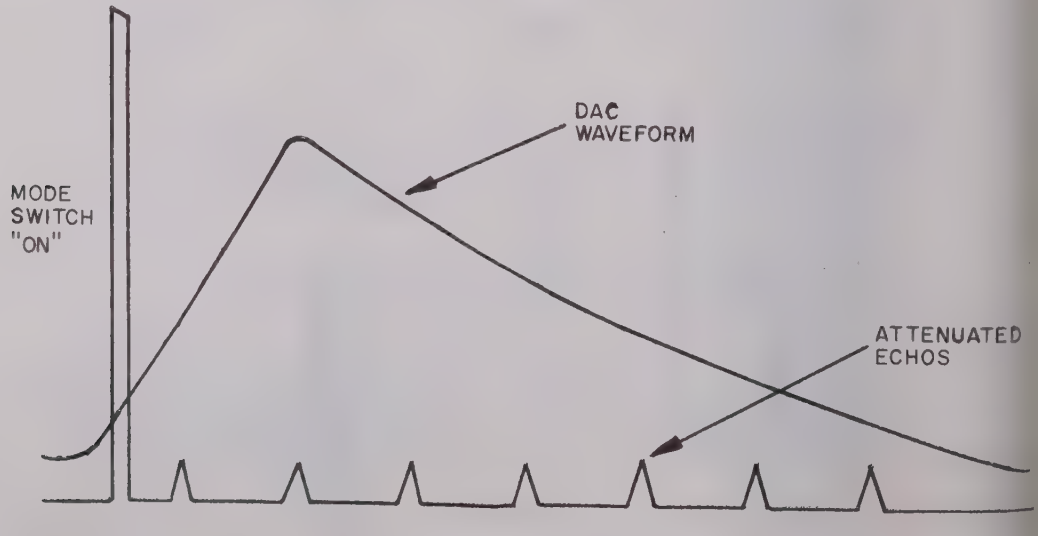


Figure 7-5a

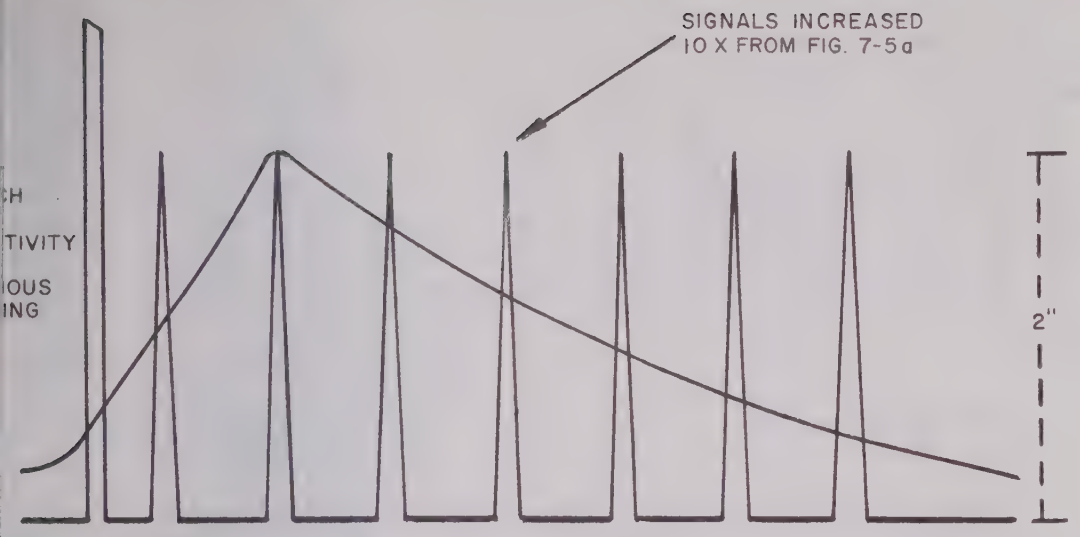


Figure 7-5b

TESTING

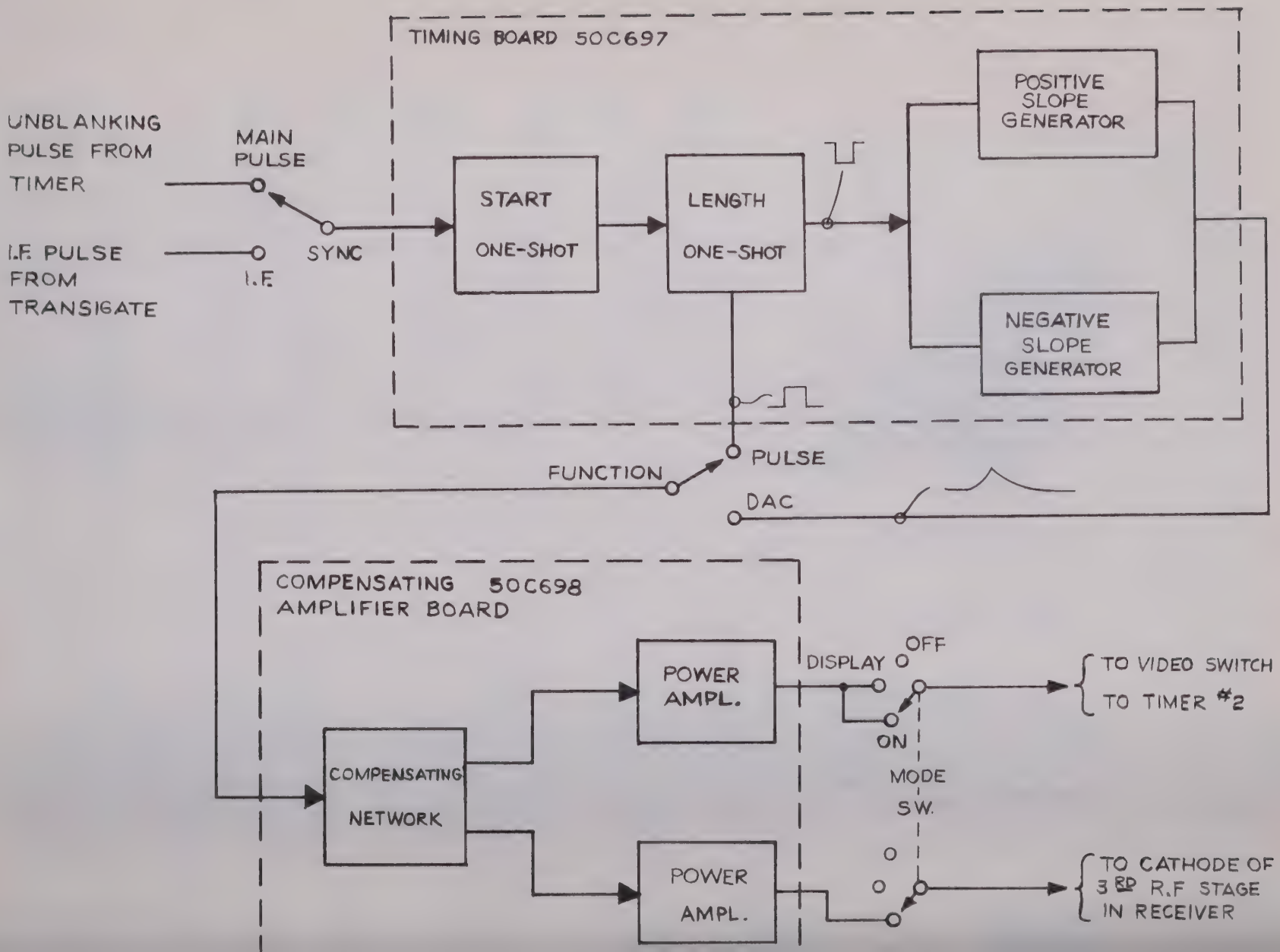
Since every test set up has different distance amplitude characteristics the DAC unit must be set up to suit the individual job by adjustment of front panel controls. The variables that affect the distance amplitude characteristic are frequency, search unit size, search unit type (i.e., focused or unfocused), and material. A DAC set up should remain fixed as long as these variables are unchanged.

Once the search unit and material are selected, next determine what the distance amplitude characteristic curve is. This can be accomplished in several ways.

a. Sperry Applications engineers can, experimentally determine the proper curve, if desired. A sample of material must be provided, as well as a description of test to be made.

b. Experimentally determine the curve by making a set of test blocks, with a flat bottomed test hole of equal size drilled in each, at varying distances covering the test range. Plot the signal amplitudes from each block, using the identical test set up to be used in practice. This curve can be marked on the CRT face with a grease pencil or a transparent overlay. Make the amplitude of the curve two inches.

c. For testing long distances, over one or two feet, an approximation of the distance amplitude characteristic (mostly far field) can be gotten by observing ultrasonic noise in a clear piece of material. An approximate correction for distance can be made by adjusting the DAC so this noise is uniform in amplitude. This method has


TIMING BOARD 50C697
UNBLANKING PULSE FROM TIMER
MAIN PULSE
I.F. PULSE FROM TRANSIGATE
I.F.
SYNC
START ONE-SHOT
LENGTH ONE-SHOT
POSITIVE SLOPE GENERATOR
NEGATIVE SLOPE GENERATOR
FUNCTION
PULSE
DAC
COMPENSATING 50C698 AMPLIFIER BOARD
COMPENSATING NETWORK
POWER AMPL.
POWER AMPL.
DISPLAY
OFF
ON
MODE SW.
TO VIDEO SWITCH
TO TIMER #2
TO CATHODE OF 3RD R.F STAGE IN RECEIVER

been used in testing six foot wide sheets, to bring up the amplitude of defects at the far side of the sheet.

Once the distance amplitude curve has been determined, place it on the CRT as a transparent overlay. Be sure the sweep is set to correspond to the horizontal scale of the curve, and that the curve is two inches to its peak amplitude. Set the Mode switch to Display and adjust the wave generator controls to match the DAC waveform as closely as possible to the overlay. Set the Mode switch to ON and adjust receiver sensitivity for desired echo amplitudes. All echo signals will now be corrected for distance. Proceed with testing.

4. PRINCIPALS OF OPERATION

a. SYSTEM DESCRIPTION

The basis for this particular DAC system is the control of receiver sensitivity as a function of time. A special feature of this system (which permits rapid selection of the DAC waveform) is the display of the DAC waveform on the marker sweep. Figure 7-6 indicates functional configuration of the DAC system.

The unblanking pulse or the I. F. pulse initiate and synchronize the DAC operation. The start one-shot and length one-shot produce a pulse whose position (relative to the unblanking of I. F. pulse) and duration can be controlled. This pulse is sent to the wave generator where it is integrated (positive slope generator), differentiated (negative slope generator), and summed. The resulting waveform is processed by the compensating network which converts it to two waveforms, each of which is different from the input waveform. After amplification, one waveform is sent to the Receiver and the other to the Timer.

The receiver sensitivity is controlled by injecting the DAC waveform into the cathode of the third r-f stage. Correct sensitivity control is accomplished whenever the displayed DAC waveform is made to match the echo peaks. The display of the DAC waveform is accomplished by injecting the DAC waveform into the display selector in the timer board.

CALIBRATION PROCEDURE

1. SET-UP PROCEDURE

a. Insert into a DAC chassis a timing board and a compensating amplifier board.

b. Set the DAC controls as follows:

(1) MODE:	DISPLAY
(2) SYNC:	MAIN PULSE
(3) FUNCTION:	PULSE
(4) AMPLITUDE:	1/2 of full clockwise
(5) LENGTH:	Pointer at position 2; vernier 1/2 of full clockw
(6) START:	Pointer at position 2; vernier full counterclockw

c. Set the Timer controls as follows:

(1) SWEEP:	Set controls to obtain visible echoes on CRT
(2) SWEEP DELAY:	As required
(3) MARKERS:	OFF

d. Set Pulser/Receiver SENSITIVITY for X 1 and PULSE LENGTH to maximum; disconnect transducer.

e. Plug in the DAC or a Servistension.

WARNING

Never insert or extract PC boards or DAC unit when UM 721 is on.

2. DAC - DISPLAY D.C. LEVEL ADJUSTMENT

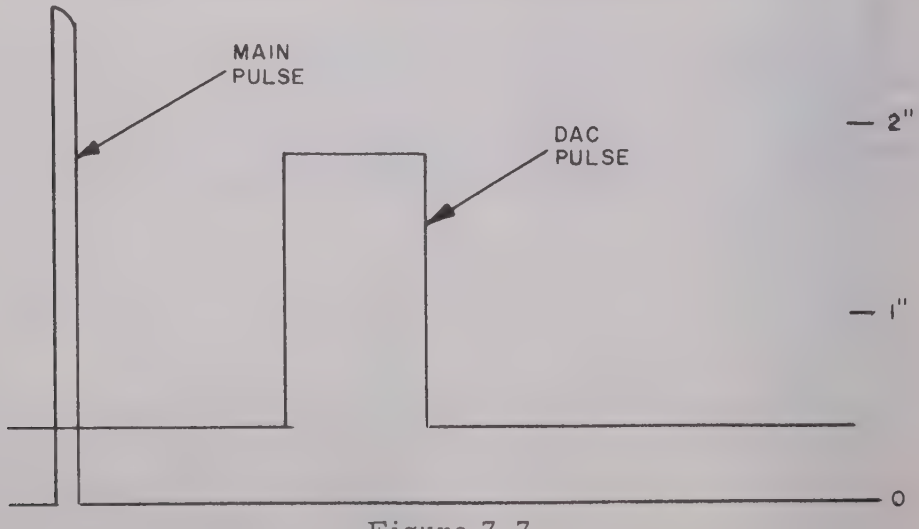


Figure 7-7

a. Observe a pattern shown in Figure 7-7 on the CRT screen.
b. Adjust R114 of the DAC unit (calibration display) until the amplitude of DAC waveform is maximum.
c. Adjust R115 (d.c. level) until DAC waveform base line is 0.2 inches above the main bang base line, as shown in Figure 7-8.

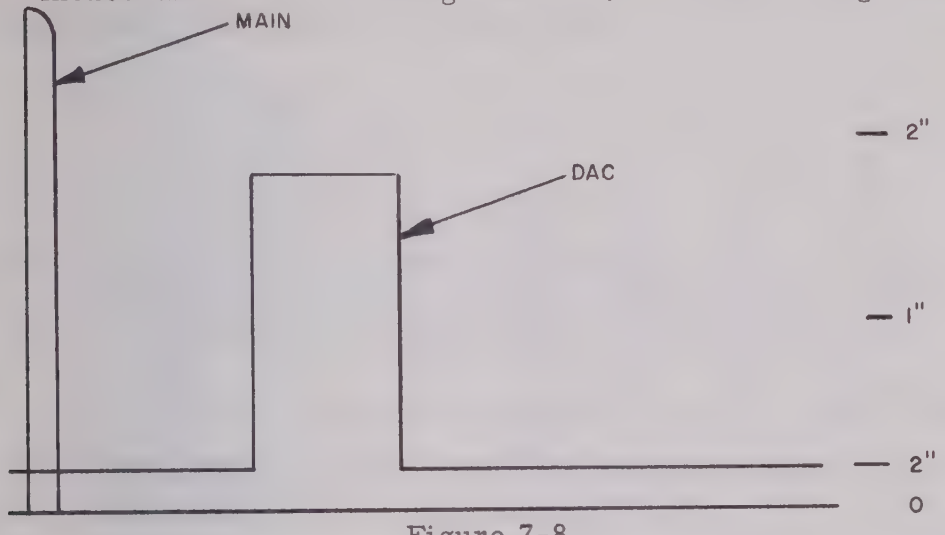


Figure 7-8

3. DAC - RECEIVER D.C. LEVEL ADJUSTMENT

a. Connect the transducer to the receiver and, by using the test block 50B1208, obtain the pattern shown in Figure 7-9. Set largest signal to 2 inches.

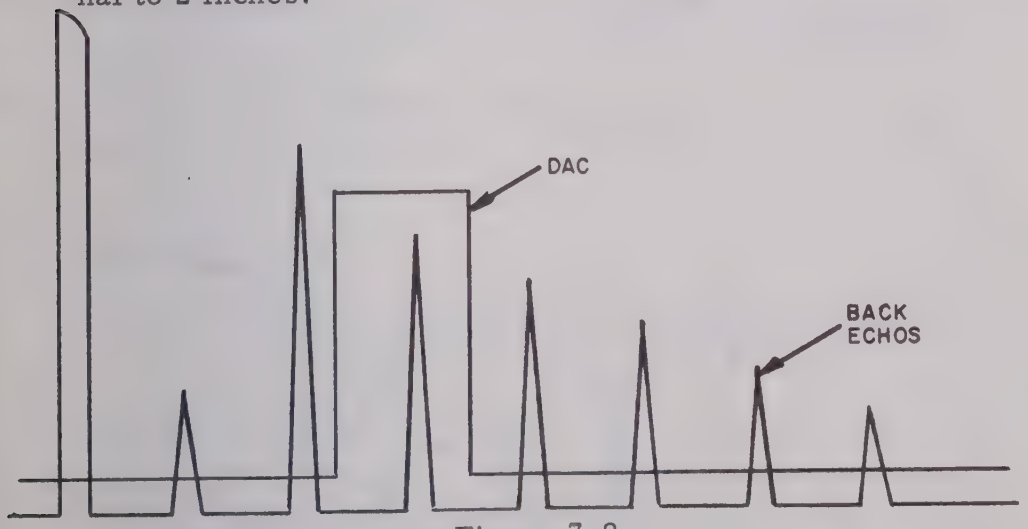


Figure 7-9

b. Set the DAC MODE switch to ON and observe the back echoes outside the DAC waveform.

c. If back echoes remain fixed in amplitude adjust R103 until the back echoes just start to decrease.

d. If back echoes decrease in amplitude, adjust R103 until the back echoes just stop increasing.

4. DAC CALIBRATION

a. Set the FUNCTION switch to DAC; MODE switch to DISPLAY.

b. Set the LENGTH switch to position 1; vernier control to full counterclockwise.

c. Set START switch to position 1.

d. Adjust the upper NEGATIVE SLOPE control, the AMPLITUDE control, and the START vernier control until the DAC waveform matches the peaks of the back echo pulse. See Figure 7-10.

e. Set MODE switch to ON; increase receiver gain by 10.

f. Adjust R106 (calibration video) till the back echoes, that previously matched the DAC waveform, are 2 $\pm$ 0.1 inches of amplitude. See Figure 7-11.

g. If the adjustment of R106 does not give the desired pulse amplitudes readjust slightly the slope and amplitude controls.

h. Decrease the receiver gain by 10 and set MODE control switches to DISPLAY.

i. Adjust R114 (calibration display) if necessary to make curve match the signals, as in Figure 7-10.

Figure 7-10

j. Set MODE switch to ON; increase receiver gain by 10. Observe a pattern similar to Figure 7-11. At this point all the back echoes that matched the DAC waveform should have an amplitude of 2 ±0.1 inches.

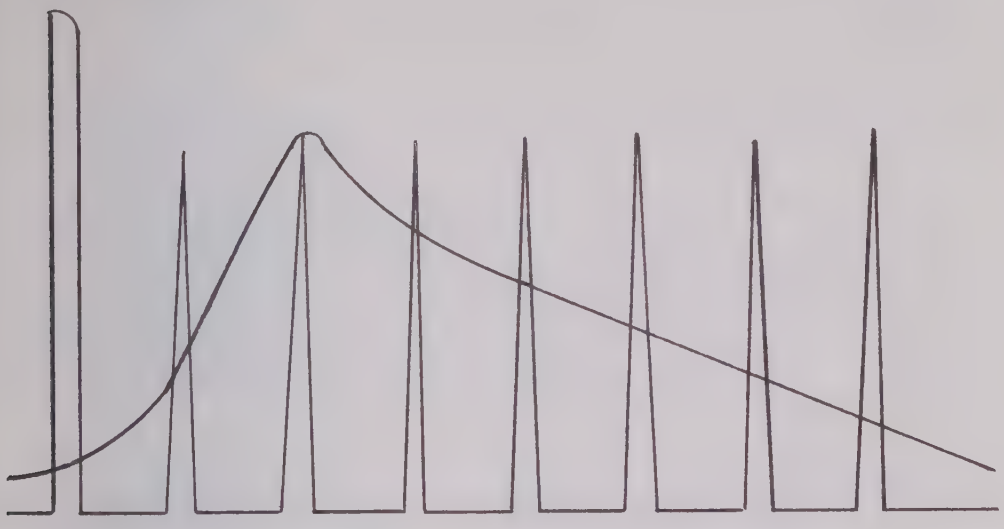


Figure 7-11

k. If step i. cannot be executed satisfactorily after adjusting R114, for best match, repeat steps e,, f., and g.

l. If the adjustment of R106 does not give the desired back echo amplitude, readjust R103 (d.c. level display) until the back echoes are 2 ±0.1 inches.

m. Repeat steps i., j., and k.

CIRCUIT DESCRIPTION

NOTE: In the description that follows use should be made of the DAC drawing 50E541.

1. TIMING BOARD, 50C697

a. GENERAL

The timing board contains the circuitry which controls the position and the shape of the DAC waveform.

b. MAIN PULSE TRIGGER

The start oneshot is triggered by either the main pulse or the I. F. (first echo) pulse. The main pulse is obtained from the Display/ Timer unit and is brought in on pin 18 of J401. This pulse is known

as the unblanking pulse and is coincident with the start of both the video and marker sweeps, thus initiating two DAC waveforms for each inspection cycle. It is a negative going pulse whose amplitude is approximately 10 volts. This pulse is differentiated by C203 and R205 and then triggers Q202 of the start oneshot.

c. I. F. PULSE TRIGGER

The I. F. sync pulse is obtained from a Transigate unit and is brought in on pin 23 of J401. It is coincident with the first echo and, unlike the unblanking pulse, occurs only once during the inspection pulse. (The consequence of the above is that, when the I. F. pulse is used as a trigger, the DAC waveform cannot be displayed.) The I. F. pulse is a positive going pulse of approximately 40 volts amplitude. This pulse is differentiated by C201 and R201 and applied to Q201. The inverted output of Q201 then triggers Q202 of the start oneshot.

d. START ONESHOT

The start oneshot is a standard version of a monostable multivibrator. Q202 is normally in a cut off state, Q203 is in a saturation state. The switching action is accomplished by turning Q202 on; this requires a negative going pulse at the base of Q202. To reduce the loading on the trigger source, CR201 is used as a disconnect diode. The output of the start oneshot is a negative going pulse whose duration is controlled by varying R302 and switching of S303. The output waveform is shown in Figure 7-12a. The output of the start oneshot is differentiated by C205 and R210 and clamped by CR202. This produces a positive going pulse which triggers the length oneshot.

e. LENGTH ONESHOT

The length oneshot is a modified version of a monostable multivibrator. Q204 is normally in the cut off state; Q205 is in the saturation state. The application of the positive going pulse at the base of Q204 switches the transistors producing a positive going pulse at the collector of Q205 and a negative going pulse at the collector of Q204. The waveform at the collector of Q204 is shown in Figure 7-12b. The duration of the pulses is controlled by R304 and S304. To insure a fast fall time for the negative going pulse, CR203 is used as a disconnect diode. To obtain a pulse duration of two microseconds, irrespective of Q205 current gain, it was necessary to introduce a saturation limiting diode CR204. The negative going pulse is applied to the complementary symmetry driver, and eventually is reshaped into a DAC waveform. The positive going pulse is applied to a driver emitter follower on the compensating amplifier board, and eventually emerges as the "pulse" waveform.

f. COMPLEMENTARY SYMMETRY DRIVER

The complementary symmetry driver Q206 and Q207 is nothing more than two emmitter followers in parallel. The parallel arrangement assures equal rise and fall times of the output pulse irrespective of capacitive loading of the negative slope generator. The output of the complementary symmetry driver is applied to the negative and positive slope generators. The output waveform is similar to the input waveform.

g. POSITIVE SLOP GENERATOR

The positive slope generator is a modified Miller integrator, Q208, Q209 and C207; the modification consists of nonlinear positive feedback, CR205, R220 and R307. The leading edge of the DAC waveform is formed by integration of the input pulse. The integration consists of two parts; up to 6 volts of output the integration constant is controlled by R306; after 6 volts of output, the zener diode CR205 breaks down, and the integration constant is controlled by both R306 and R307. The output from the emitter of Q209 is shown in Figure 7-12c.

h. NEGATIVE SLOPE GENERATOR

The negative slope generator consists of two differentiators (C209, R225, R308, and C208, R311, R309). The use of the two differentiators permits independent adjustment of the upper and lower portions of the lagging edge of the DAC waveform. The slope of the upper portion is controlled by R308. The slope and the amplitude of the lower portion is controlled by R309 and R312 respectively. Diodes CR206 and CR207 are used to clamp the differentiator output to ground level. Resistance R224 and diodes CR209, CR210, CR208, eliminate interaction of the various slope segments. Diode CR211 is used to eliminate a d. c. level associated with output of the positive slope generator. The outputs of the positive and negative slope generators are combined and after passing through the Function switch are applied to the driver emitter follower on the compensating amplifier board.

2. COMPENSATING AMPLIFIER BOARD, 50C698

a. GENERAL

The function of the compensating amplifier is to convert the incoming waveform to two waveforms: the DAC-display waveform and DAC-receiver waveform, and to raise the d. c. level of each of the waveforms to a specific value.

b. DRIVER E. F.

The driver emitter follower (Q101) is a common collector amplifier; R301 serves as gain control. The input signal with the FUNCTION

switch in the DAC position is shown in Figure 7-12d. The driver output is applied to the compensating network.

c. COMPENSATING NETWORK

The compensating network converts the input waveform to two amplitude modified waveforms.

The compensating network is composed of two nonlinear voltage dividers. The nonlinear voltage division is accomplished by use of diodes (CR109, CR108, etc.) and resistors (R112, R111, etc.) in parallel; as the voltage level is increased some of the diodes begin to conduct, with the consequence that the voltage division ratio is decreased in the case of one divider (R109, R106, etc.) and increased in the case of the other divider (R112, R114, etc.) The output waveforms are sent to d.c. level shifters.

d. D.C. LEVEL SHIFTERS

One type of d.c. level shifter is used to change the d.c. level of both the DAC-display and DAC-receiver waveforms. The DAC-display waveform is shifted to approximately +1 V level and the DAC-receiver waveform is shifted to approximately +2 V level.

The d.c. level shifter is composed of a constant current source (Q103 or Q106) and an emitter follower (Q104 and Q105). The current through Q103 or Q106 is approximately 3 ma thus permitting a maximum of +3 V level change. The d.c. level shifter output is applied to the receiver and display emitter followers.

e. RECEIVER E.F.

The receiver emitter follower power amplifies and filters the DAC-receiver waveform. The emitter follower load is the cathode bias resistor (200 ohms) and bypass capacitor (3300 uuf) of the receiver third RF stage. The filtering is accomplished by L101 and C101. Zener diode, CR101, is used to reduce the heating of Q102 and Q107. The output waveform (Figure 7-12e) except for rounding of corners due to filtering, is similar to the input waveform.

f. DISPLAY E.F.

The display emitter follower (Q107) power amplifies and filters the DAC-display waveform. The filtering is accomplished by C102, L102 and C103. The emitter follower output is applied to pin 14 of J401 and then to the Display/Timer unit. The output waveform, Figure 7-12f, except for rounding of corners due to filtering, is similar to the input.

3. MAINTENANCE

WARNING: Never connect or disconnect transistorized plug-in units or P. C. Boards when UM Reflectoscope is ON.

a. GENERAL

(1) Test and Associated Equipment:

The following test and associated equipment is required for checking the DAC unit.

a. Servistension style 50C495.
b. Tektronix 513, or equivalent.
c. VOM, Simpson Model 260.
d. DAC Test Block 50B1208.

PERSONAL SAFETY WARNING:
Lethal voltages are present - always turn instrument OFF when changing components. Always keep one hand in clear when making temporary connections (connecting test loads, etc.)

NOTE

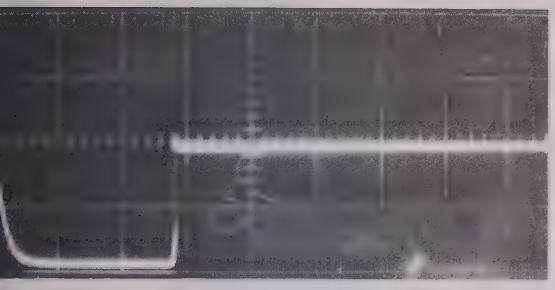
PRESET DAC CONTROLS:

1. Rotate START and LENGTH switches to position 1.
2. Rotate POS SLOPE UPPER and LOWER rheostats and NEG SLOPE UPPER and LOWER rheostats to full CCW position.
3. Rotate AMPLITUDE potentiometer to full CW position.
4. Rotate CUTOFF potentiometer to full CCW position.
5. Set FUNCTION switch to DAC position.
6. Set MODE switch to ON position.
7. Set SYNC switch to MAIN PULSE position.

PRESET TEST OSCILLOSCOPE CONTROLS:

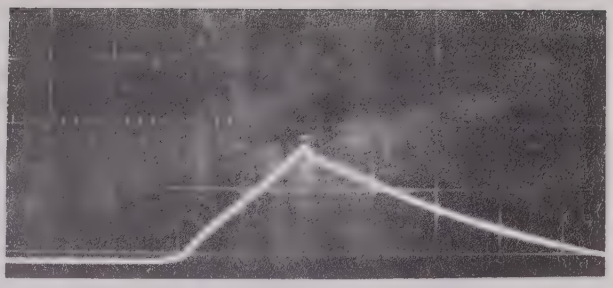
1. Sweep time at 50 microsec/CM.
2. Vertical volts/cm at 5.
3. Waveforms are 0 volts DC at bottom of screen on CRT with exception to figure B which is 0 volts at horizontal graticule line.

Figure 7-12. Waveform Chart
(Sheet 1 of 2)



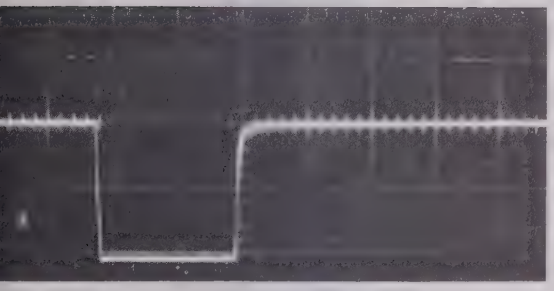
A

Collector Q203



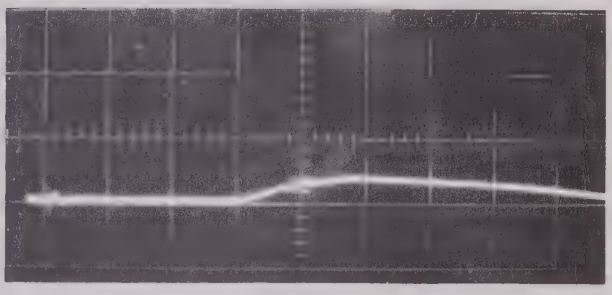
D

Pin 20 J101



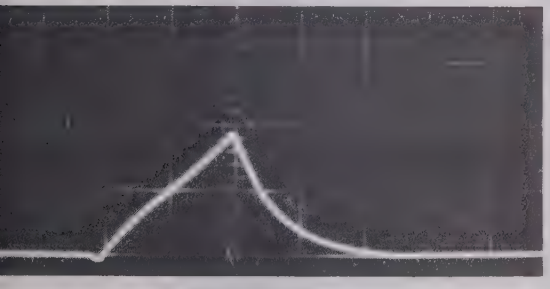
B

Collector Q204



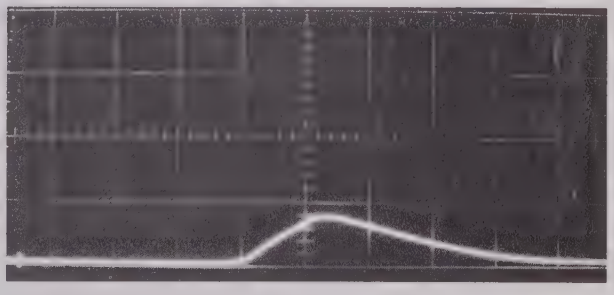
E

Pin 4 J101



C

Emitter Q209



F

Pin 18 J101

Figure 7-12. Waveform Chart
(Sheet 2 of 2)

COMPENSATING AMPLIFIER BOARD ASSEMBLY
Reference Schematic 50E541

Schematic Symbol No.	Sperry Part No.	Description
C101	Arco	Capacitor .0015uf 600v ±10% 6DP-1-152
C102	Arco	Capacitor .0015uf 600v ±10% 6DP-1-152
C103	Arco	Capacitor .002uf 600v ±10% 6DP-1-202
CR101	1N752	Diode 1N752 5.8v Zener
CR102	Hoffman	Diode HB1
CR103	Same as CR102	
CR104	Same as CR102	
CR105	1N90	Diode 1N90
CR106	Same as CR102	
CR107	Same as CR102	
CR108	Same as CR105	
CR109	Same as CR102	
CR110	Same as CR105	
J101	Elco	Connector 5004-20-B-2-1-B-T5 & T18
L101	DRA003A08	RF Choke 100uh
L102	J. W. Miller Prods.	RF Choke 270uh 72F274AP
Q101	2N585	Transistor 2N585
Q102	Same as Q101	
Q103	2N404	Transistor 2N404
Q104 thru Q106	Same as Q103	
Q107	Same as Q101	
R101	DPA004C08	Resistor 2K 1/2W ±5%
R102	DPA004B21	Resistor 680 ohms 1/2W ±5%
R103	Bourns	Potentiometer 1K 275-1-102
R104	DPA004C01	Resistor 1K 1/2W ±5%
R105	DPA004C11	Resistor 2.7K 1/2W ±5%
R106	Bourns	Potentiometer 2K 275-1-202
R107	Same as R104	
R108	DPA004B23	Resistor 820 ohms 1/2W ±5%
R109	DPA004C15	Resistor 3.9K 1/2W ±5%
R110	DPA004C12	Resistor 3K 1/2W ±5%
R111	DPA004D01	Resistor 10K 1/2W ±5%
R112	DPA004D03	Resistor 12K 1/2W ±5%
R113	DPA004C05	Resistor 1.5K 1/2W ±5%
R114	Bourns	Potentiometer 500 ohms 275-1-501
R115	Same as R103	
R116	Same as R104	
R117	Same as R101	
R118	Same as R102	
R119	DPA004B10	Resistor 240 ohms 1/2W ±5%

TIMING PC BOARD
Reference Schematic 50C697

C201	Arco	Capacitor 100uuf 500v ±10% DM-15-101
C202	Arco	Capacitor 1000uuf 100v ±10% DM-15-102
C203	Arco	Capacitor 500uuf 300v ±10% DM-15-501
C204	Arco	Capacitor 300uuf 500v ±10% DM-15-301
C205	Same as C203	
C206	Same as C204	
C207	Arco	Capacitor .0015uf 600v ±10% 6DP-1-152
C208	Arco	Capacitor .05uf 100v ±10% 1DP-2-503
C209	Arco	Capacitor .02uf 100v ±10% 1DP-1-203
CR201	1N90	Diode 1N90
CR202	Hoffman	Diode HB3
CR203	Same as CR201	

TIMING PC BOARD (Cont.)
Reference Schematic 50E541

Schematic Symbol No.	Sperry Part No.	Description
CR204	Same as CR201	
CR205	1N709A	Diode 1N709A 6v Zener
CR206	Same as CR201	
CR207	Same as CR201	
CR208	Same as CR201	
CR209	Same as CR201	
CR210	Same as CR201	
CR211	Same as CR202	
J201	Elco	Connector 5004-20-B-2-1-B-T3 & T11
Q201	2N585	Transistor 2N585
Q202	2N404	Transistor 2N404
Q203	Same as Q202	
Q204	Same as Q201	
Q205	Same as Q201	
Q206	Same as Q202	
Q207	Same as Q201	
Q208	Same as Q201	
Q209	Same as Q201	
R201	DPA004D11	Resistor 27K 1/2W ±5%
R202	DPA004B21	Resistor 680 ohms 1/2W ±5%
R203	Same as R201	
R204	DPA004C08	Resistor 2K 1/2W ±5%
R205	DPA004C18	Resistor 5.1K 1/2W ±5%
R206	Same as R201	
R207	DPA004C01	Resistor 1K 1/2W ±5%
R208	Same as R205	
R209	Same as R207	
R210	Same as R201	
R211	Same as R207	
R212	Same as R207	
R213	Same as R205	
R214	Same as R202	
R215	Same as R204	
R216	Same as R204	
R217	DPA004B10	Resistor 240 ohms 1/2W ±5%
R218	DPA004C21	Resistor 6.8K 1/2W ±5%
R219	DPA004B07	Resistor 180 ohms 1/2W ±5%
R220	DPA004C10	Resistor 2.4K 1/2W ±5%
R223	Same as R204	
R224	Ohmite	Resistor 6.8 ohms 1W ±5%
R225	Same as R207	
R226	Same as R202	
R227	Same as R202	

FRONT PANEL ASSEMBLY
Reference Schematic 50E541

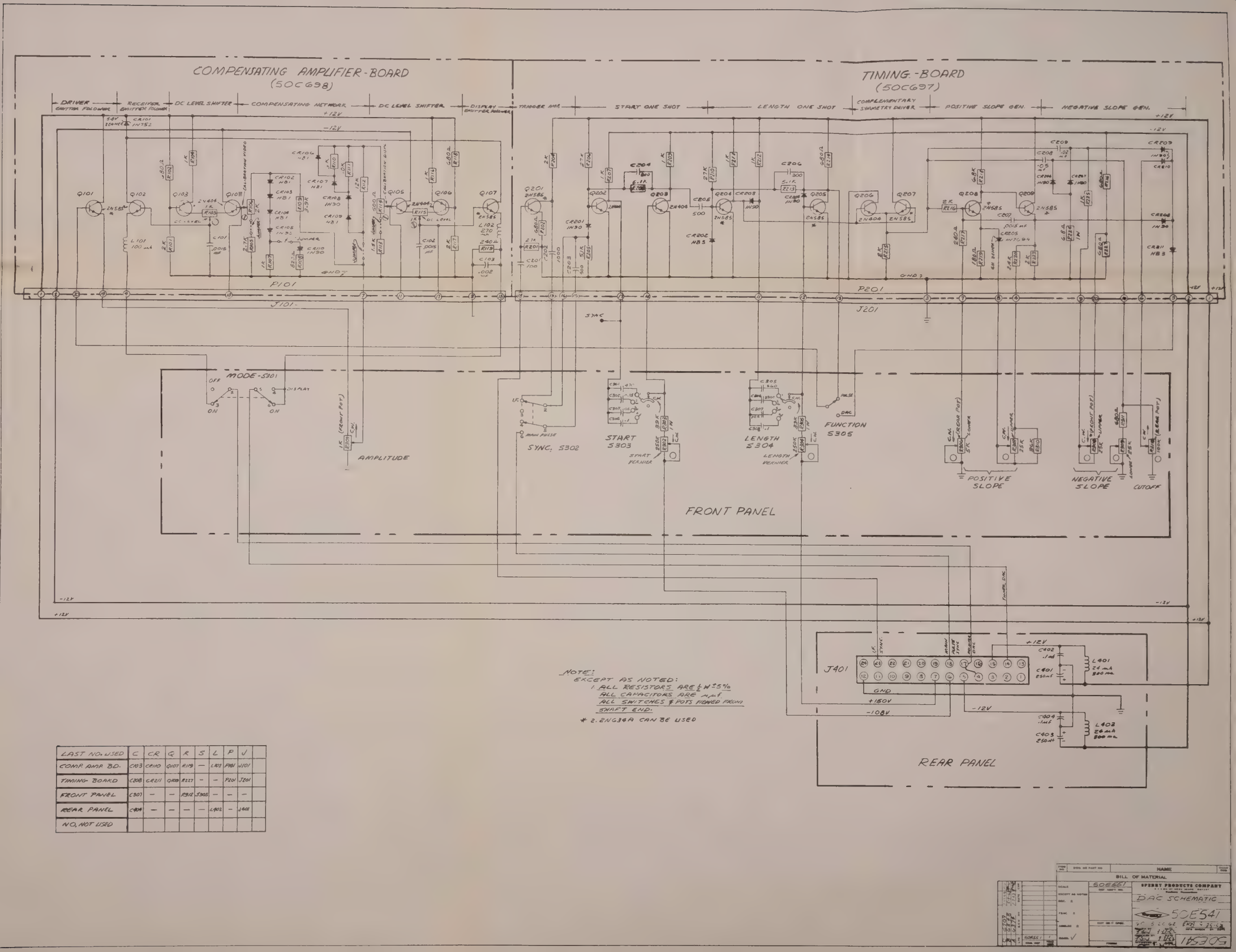
C301	DQB009B18	Capacitor 470uuf 500v ±5%
C302	Arco	Capacitor .0025uf 600v ±5% 6DP-1-252
C303	Arco	Capacitor .015uf 400v 4DP-1-153
C304	Arco	Capacitor .1uf 100v 1DP-2-104
C305	DQB009B21	Capacitor 560uuf 500v ±5%
C306	Arco	Capacitor 3900uuf 500v DM-20-392
C307	Arco	Capacitor .025uf 100v 1DP-1-253
C308	Arco	Capacitor .1uf 100v 1DP-2-104
R301	50A2925	Potentiometer 1K (P/O R301-312 Ass'y)
R302	50B1129	Potentiometer 250K (P/O R302-S303 Ass'y)
R303	DPA007D08	Resistor 39K 1W ±10%
R304	Same as R302	
R305	Same as R303	
R306	50A2927	Potentiometer 5K (P/O R306-R307 Ass'y)

FRONT PANEL ASSEMBLY (Cont.)
Reference Schematic 50E541

Schematic Symbol No.	Sperry Part No.	Description
R307	50A2927	Potentiometer 25K (P/O R306-R307 Ass'y)
R308	50A2926	Potentiometer 25K (P/O R308-R309 Ass'y)
R309	50A2926	Potentiometer 25K (P/O R308-R309 Ass'y)
R310	DPA004D14	Resistor 36K 1/2W ±5%
R311	DPA005B11	Resistor 680 ohms 1/2W ±10%
R312	50A2925	Potentiometer 100K (P/O R301-R312 Ass'y)
S301	Stackpole	Switch SS-50
S302	Stackpole	Switch SS-16
S303	50B1129	Switch (P/O R302-S303 Ass'y)
S304	Same as S303	
S305	Stackpole	Switch SS-26-1

REAR PANEL

C401	DQL001A22	Capacitor 250uf 25v
C402	DQG002A04	Capacitor 1uf 200v
C403	Same as C401	
C404	Same as C402	
J401	CQC017P01	Plug
L401	J. W. Miller Products	R. F. Choke 24uh 300ma #4626
L402	Same as L401	



NOTE:
EXCEPT AS NOTED:
1. ALL RESISTORS ARE ±5%
ALL CAPACITORS ARE μμf
ALL SWITCHES & POTS VIEWED FROM SHAFT END.

* 2.2NG36A CAN BE USED

LAST NO. USED	C	CR	Q	R	S	L	P	J	
COMP. AMP. BD.	C103	CR110	Q107	R119	—	L101	P101	J101	
TIMING BOARD	C208	CR211	Q209	R227	—	—	P201	J201	
FRONT PANEL	C307	—	—	R312	S305	—	—	—	
REAR PANEL	C404	—	—	—	—	L402	—	J401	
NO. NOT USED									

BILL OF MATERIAL

SPERRY PRODUCTS COMPANY

DAC SCHEMATIC

50E541

SECTION VIII

TYPE UM 710 SPECIAL FUNCTION CABINET

DESCRIPTION

1. GENERAL (Figure 8-1 and Figure 8-2)

The Type UM 710 Special Function Cabinet is designed to house plug-in accessory components which will increase the versatility and range of applications of the basic UM Reflectoscopes by providing a wide variety of special functions for recording, gating, controlling, counting, and alarm purposes.

Figure 8-1
Special Function Cabinet With UM Reflectoscope

The Special Function Cabinet is designed to mount either beneath or above Type UM Reflectoscopes. Additional cabinets may be added as required to increase special function capabilities by providing for the use of more plug-in components. The Special Function Cabinet is the same size as the Type UM Reflectoscope and uses the same two-part gray, vinyl-clad skin.

Figure 8-2
Rear View of Special Function Cabinet
With UM Reflectoscope

2. TYPICAL APPLICATION (Figure 8-3 and Figure 8-4)

Many different configurations are possible when the Special Function Cabinet is combined with a Type UM Reflectoscope. Gating units may be combined with recording units, additional Pulser-Receiver units may be combined with gating units to greatly increase the number of channels available, additional Timer Units and Pulser-Receiver Units may be combined, etc.

To illustrate the relationship of the Special Function Cabinet to UM Reflectoscopes a typical application has been chosen and is shown in Figure 8-3. In this application gating units are combined with recording units to fit the requirements of a testing situation. In the following discussion the numbers in parentheses refer to the index numbers of the figure.

a. The Special Function Cabinet (1) provides the space for six plug-in components. A total of 4 gating units could be accommodated in the front panel. The rear of the compartment could accept two recording units.

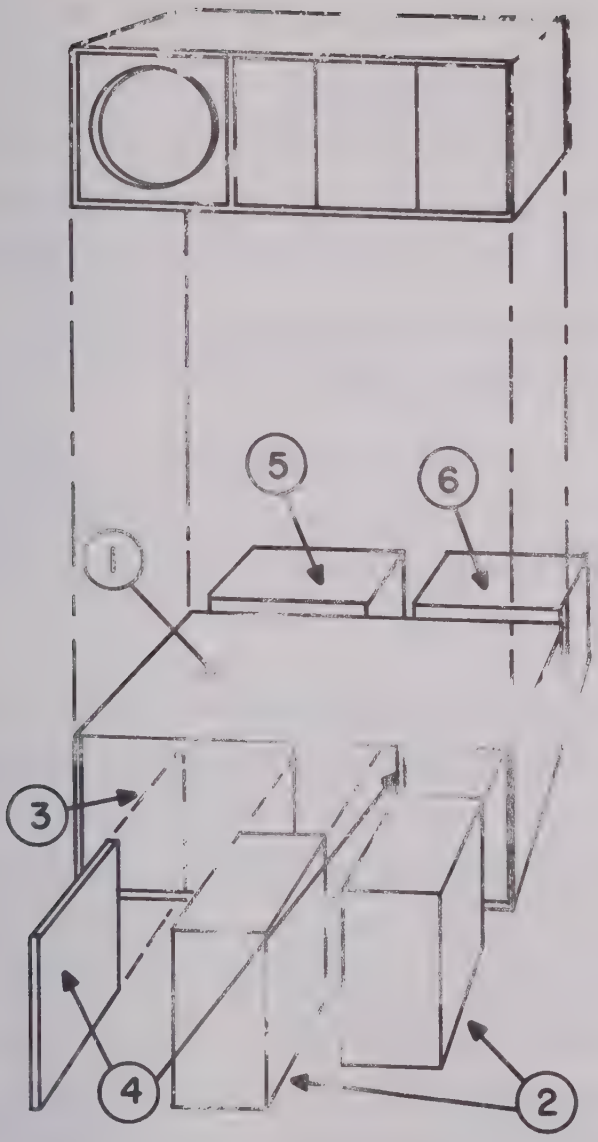


Figure 8-3
Typical Application - Mechanical Relationships

b. The Style 50E550 Transigate (2) would effectively extend the range of application of the UM Reflectoscope by establishing specific controllable "gate areas" or "zones" for examination within a test piece. (Section IX covers the Transigate units in detail.)

c. If two Transigate units are used a wide accessory drawer (3) could be used to fill the space provided for two additional plug-in components.

d. If more than two Transigate units were used, a barrier Panel Kit (4) could be fitted to the chassis to provide space for two more Transigates.

e. Either one or two Style 50E530 Recording Amplifiers (5) could be used. (Section X covers the Recording Amplifier in detail.)

f. Either one or two Relay Chassis (6) could be used. (Section XI covers the Relay Chassis in detail.)

The minimum number of special function plug-in components included with each Special Function Cabinet is one front panel and one rear panel chassis. Empty cabinet compartments are covered with blank panels or the drawer assembly already mentioned.

Figure 8-4 is a functional diagram which shows how the range of application of a UM Reflectoscope can be extended through addition of the Special Function Cabinet with plug-in components. In this typical application, combining of the Reflectoscope and the Special Function components establishes zones or gates for a specific test specimen (as many as four zones or gates with one Special Function Cabinet). The gate which has been established by a particular Transigate is displayed on the UM Reflectoscope. Aural and visual alarms on the Transigate unit proper may be set to respond to a signal (which is displayed in the gate on the UM Reflectoscope) or lack of signal from a specific zone. In addition, through the Recording Amplifier or Relay Chassis units (or a wide variety of external components) the gating or zoning capability makes possible automatic testing at production speeds wherein defects in material are detected, automated signaling or marking devices actuated, and machinery operation controlled.

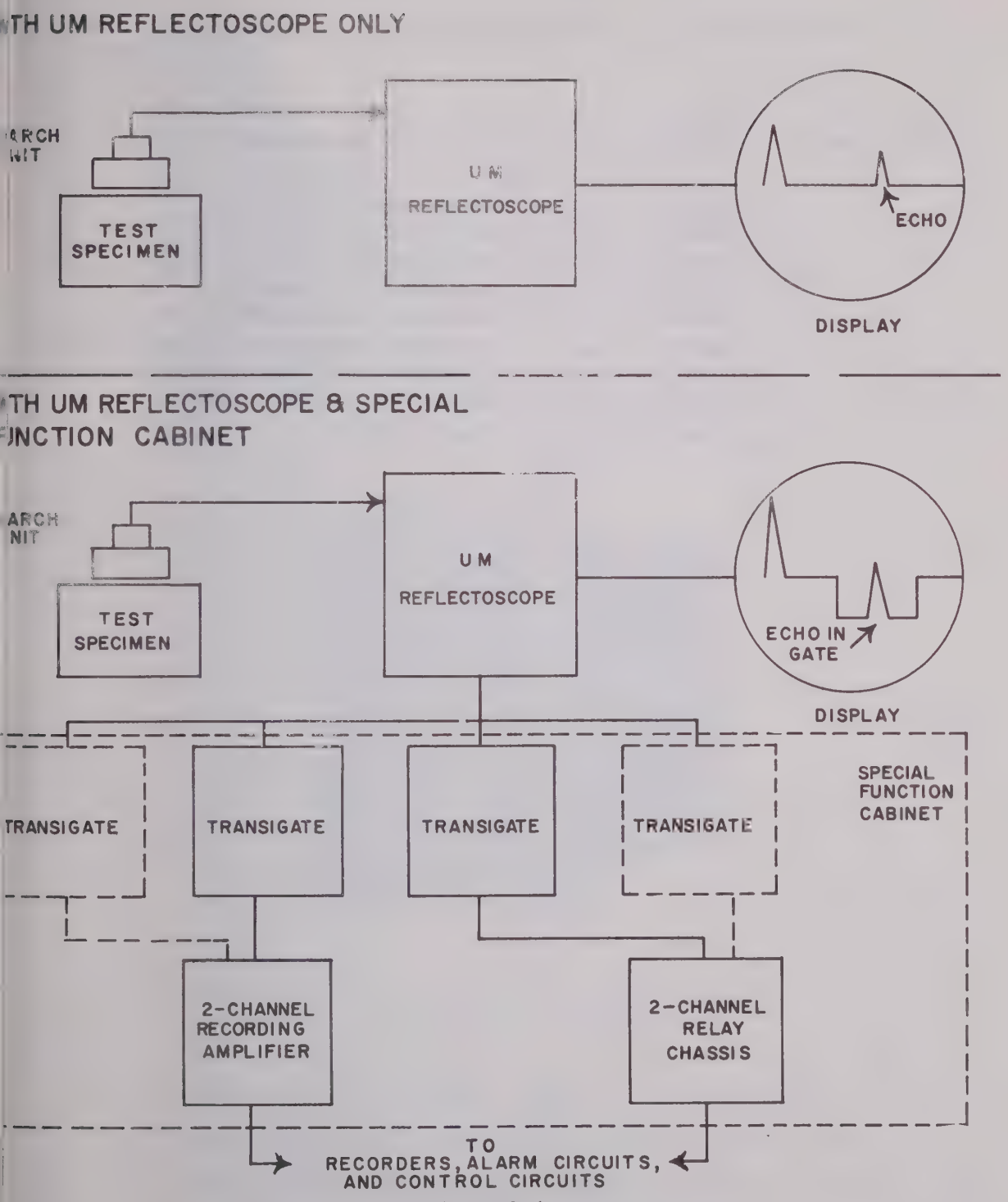


Figure 8-4
Typical Application - Functional Diagram

PARTS LIST

TYPE UM 710 SPECIAL FUNCTION CABINET - STYLE 50B710

Schematic Symbol No.	Sperry Part No.	Description
	50D256	Cabinet Assembly
	50C417	Rear Panel
	50C414	Front Panel
	50B811	Shield Barrier Assembly
	50B810	Shield Barrier Assembly
	Southco	Adjustable Panel Latch Fastener 45-99-131-
	Southco	Adjustable Panel Latch Fastener 45-14-101-
	50A2705	Handle
	Atlantic Rubber Co.	Bumper 868-2

SECTION IX

TRANSIGATE - STYLE 50E550

DESCRIPTION

1. GENERAL

The Transigate has been designed to plug into the Special Function Cabinet for operation with Type UM Reflectoscopes. Used in combination with other Special Function components or external monitoring equipment, the Transigate provides flexibility in establishing ultrasonic inspection systems for semi-automatic or automatic detection of flaws in materials at production speeds. This is accomplished by setting up specific, controllable gated areas or zones within a test piece. Signals appearing within these gates may be monitored automatically to operate visual and/or aural alarms.

Figure 9-1
Front View of Transigate

The Transigate incorporates a single channel gate (adjustable in start and length) and a discriminator level set. An interface sync control may be used to lock the gate start position (and sweep circuits if timer marker switch is set to I. F. position) on the first signal received after the initial pulse (first echo signal - usually the entrant surface of the test piece). Using immersed testing techniques, this assures that any variation of water path distance

(distance between the search unit and the surface of the test piece) will no affect the position of signals, markers, or gates appearing along the swee Visual and aural alarms are included in the form of a panel light and an internal buzzer. Output of recording and alarm information is also provid for operation of other Special Function components or for external contro and recording devices.

The Transigate may be disabled by a simple GATE OFF switch without disturbing other set-up conditions in the Special Function Cabinet or in th UM Reflectoscope. Additional Transigates may be added to meet the requ ments of tests where more than one area of a test piece is to be inspected one pass or where response to more than one level within a single area is

The Transigate consists of the following major components:

a. ECHO GATE 50C384

Printed circuit board containing circuitry for generation of the squa wave used to establish the "gate" or "zone" and the gated video amp fier which passes signals from the UM Reflectoscope through the "z to the Recorder Board. Also sends gate image signal to UM Reflecto Display (figure 9-2).

b. RECORDER BOARD 50C385

Printed circuit board containing circuitry for accepting gated video ECHO GATE, establishing DC level proportional to video signal am tude, and furnishing amplitude and on-off signals to alarm circuitry ALFAX Recorders, and penmotor type recorders.

c. ALARM BOARD 50C386

Printed circuit board containing circuitry for accepting alarm signa from RECORDER, functioning as automatic or manual reset device driving aural and visual alarm devices.

d. INTERFACE OR FIRST ECHO SYNC 50C387

Printed circuit board containing circuitry for gating video to elimi main bang, generating trigger in response to first echo or interfac signal which is sent to ECHO GATE circuitry, and providing marke

sweep sync to allow marker shift in relation to main sweep on UM Reflectoscope (with Time Control Unit MARKER control in IF position).

e. FRONT AND REAR PANEL ASSEMBLY

Structural portion of Transigate which accepts individual circuit boards; containing audio and visual alarms and external controls on front panel and connectors for interconnecting Transigate in Special Function Cabinet and with UM Reflectoscope on rear panel.

2. MECHANICAL SPECIFICATIONS

The Transigate plugs into the Special Function Cabinet and is easily disconnected for servicing or interchange. The following front panel controls are provided:

a. GATE CONTROLS:

START (pointer)
START (vernier)
LENGTH (pointer)
LENGTH (vernier)
GATE OFF and Indicator Lamp

b. ALARM CONTROLS:

LEVEL (vernier)
+ AUTO RESET (pointer)
- AUTO RESET (pointer)
+ MANUAL RESET (pointer)
- MANUAL RESET (pointer)
RESET LIGHT SWITCH
AUDIO ON-OFF

c. SYNC CONTROLS:

MAIN PULSE (pointer)
FIRST ECHO (pointer)
MARKER SHIFT (vernier)

3. ELECTRICAL SPECIFICATIONS

All power requirements are obtained from the UM Reflectoscope Display Unit.

4. GATES

Gate Start - 2 u sec. to 3000 u sec. (1/4 in. to 30 ft. in steel).

Gate Length - 2 u sec. to 3000 u sec. (1/4 in. to 30 ft. in steel).

5. RECORDING SIGNALS

a. To operate strip-chart recorders on any signal appearing in the gate area, a DC recording signal (+12 to 0 v) is provided that is proportional to the largest unsaturated signal in the gate. This signal has instantaneous response. Duration is equal to one repetition-rate cycle plus the time to the end of the next gate - or as long as signals remain in the gate.

b. For purposes of selective alarming on signals that either exceed or fall below a set level (positive or negative response), the Transigate provides a DC on-off signal (0 and -10 vdc). This can be used for facsimile recorders or for relay and solenoid operation.

6. RANGE OF LEVEL CONTROL

Range of the alarm LEVEL control is 1/8 in. to 3 in. (full scale).

7. OPERATING TEMPERATURE RANGE

Stable and reliable operation is provided over the range 0°F. to 120°F.

OPERATION

1. FUNCTION OF CONTROLS (Figure 9-1)

a. GATE CONTROLS (COMBINATION VERNIER AND POINTER)

(1) START (pointer)

Provides coarse positioning of the gate start (figure 9-2).

(2) START (vernier)

Permits fine, continuous control of the gate start position between the coarse ranges noted above.

(3) LENGTH (pointer)

A coarse control which sets the width (or length) of the gate (figure 9-2).

(4) LENGTH (vernier)

Provides a fine continuous control of gate width between the coarse ranges noted above.

(5) GATE OFF

Permits the disabling of gate without disturbing any of the variable controls. When the lamp is OFF, the gate is ON.

b. ALARM CONTROLS (COMBINATION VERNIER AND POINTER)

(1) LEVEL (vernier)

Establishes the signal level (on the UM Reflectoscope display) at which alarms, relays or on-off printing will be activated or initiated (figure 9-2).

(2) + AUTO RESET (pointer)

Sets up systems to alarm when any displayed signal within the gate (figure 9-2) increases above the level set by the LEVEL control. The alarm buzzer will sound and the panel light will remain on for a minimum of 0.1 sec., or as long as a signal above the level set remains in the gated area. Alarm circuits reset automatically when the signal decreases in amplitude below the alarm level, or is no longer in the gate.

(3) - AUTO RESET (pointer)

With the control in this position, the system is set to alarm when the signal within the gated area falls below the level set by the LEVEL control. Alarms will remain activated for a minimum of 0.1 sec., or as long as the signal remains below the level set in the gate. Alarm circuits reset automatically when the signal increases in amplitude above the alarm level.

(4) + MANUAL RESET (pointer)

This control position sets the system to alarm on any signal appearing in the gate having an amplitude greater than that set by the LEVEL control. The alarms (light and buzzer) will remain activated until reset manually by pressing the RESET light switch.

(5) - MANUAL RESET (pointer)

Sets the system to alarm when the signal appearing within the gated area falls below the level that has been pre-set by the LEVEL control. A single video pulse that drops below the level set will activate the alarms (buzzer and light) which must then be reset manually by pressing the RESET light switch.

(6) RESET LIGHT SWITCH

The RESET light is activated by an alarm signal and remai until reset automatically or manually as described above.

(7) AUDIO ON-OFF

This switch controls the buzzer alarm. If no audible alarm this switch is set to OFF

NOTE

In all of the above conditions (alarm, level and reset), an on-off type printing signal is available. The minimum duration of this signal is the period of one rep-rate plus the time to the end of the next gate, or as long as there is video present to maintain the signal. The start of printing is coincident with alarming. Output voltage is 0 to -8 volts. Output impedance is 1K ohms. Signal output is also available to drive low power relays or solenoids. This output is present as long as the alarm light is energized. Output is half wave, 60 cps at 8.8 volts peak. Output impedance is less than 50 ohms. See operation sections for Type S Recording Amplifier and Type R Relay Chassis.

c. SYNC CONTROLS

(1) MAIN PULSE (pointer)

With the control in this position, the start of the gate is syn by the initial pulse or "main bang". The gate start is initiat trigger pulse that is coincident with, or slightly ahead of the edge of the initial pulse or "main bang".

(2) FIRST ECHO (pointer)

In this position, the system is synchronized by the first ech to appear - presumably the interface or entrant signal. Whe immersed testing techniques, this permits setting the gate t only the material under test while ignoring signal variations by changing water path distance. Immediately after the "ma a delay is created during which no returning video can synch

the ECHO GATE and marker sweep circuits. This delay time (9 - 80 u sec) is adjustable by R504 (internal) on the INTERFACE SYNC board, and is factory set for 20 u sec. In some cases it may be necessary to adjust this delay beyond some fixed echo prior to interface.

(3) MARKER SHIFT (vernier)

When the sync switch is in the FIRST ECHO position and the marker control on the Time Control Unit is in the IF position, a second trace will always be present on the CRT. The markers will be on this trace and their horizontal position (relative to the video trace) can be varied without disturbing the marker calibrations (figure 9-2).

2. FAMILIARIZATION (Figure 8-1, 9-1 and 9-2)

a. SET-UP

(1) Assemble a Search Unit, UM Reflectoscope with Special Function Cabinet, and a test specimen.

(2) Check that the Transigate unit is in position and properly secured.

(3) If a Type S Recording Amplifier or a Type R Relay Chassis is being used, check the OPERATION sections on these units for proper procedure.

(4) Turn on the UM Reflectoscope and with GATE control on Transigate to ON obtain a video trace and marker trace similar to that shown in Figure 9-2.

NOTE

Always turn power off when plugging special function components in or taking them out.

b. FAMILIARIZATION - GENERAL

Manipulate the various controls on the Transigate and observe the effects they have on the UM Reflectoscope presentation.

c. FAMILIARIZATION - DETAIL

(1) With a presentation on the UM Reflectoscope similar to that shown in Figure 9-2 move the pointer on the SYNC control from MAIN PULSE

to FIRST ECHO (switch on Time Control unit to I. F.) and obs
effect on the traces. Leave the pointer on FIRST ECHO posit
video and the marker trace are now being synchronized by th
echo (presumably the entrant signal).

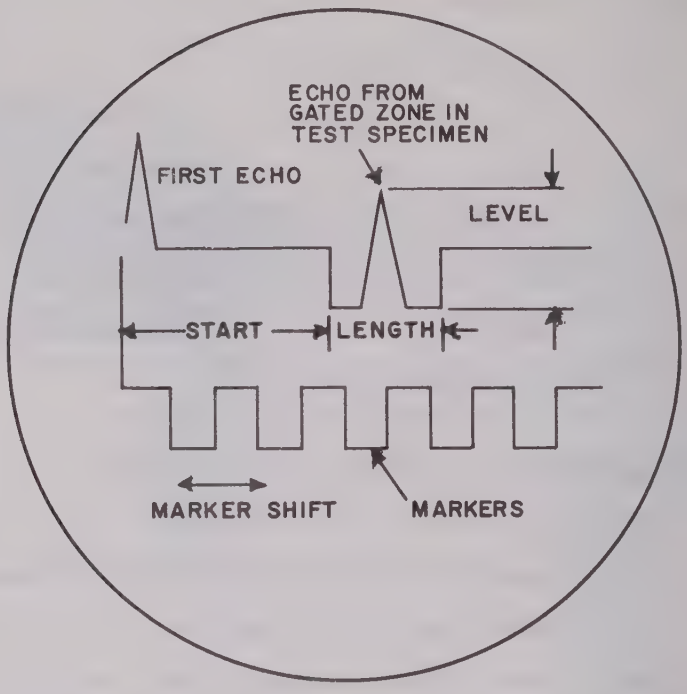


Figure 9-2
UM Reflectoscope Presentation with Transigate On

(2) Go next to the GATE controls on the Transigate. Move the ST
pointer and observe that the gate image is moved across the s
in jumps, and that it will disappear to the right if the sweep c
on the UM Reflectoscope are not readjusted. Next adjust the v
on the START control and note that it will position the gate im
continuously between the steps created by the pointer. Thus a
"zone" in the test specimen after the first echo (from the entr
can be set up for examination.

(3) Next adjust the pointer on the LENGTH control and observe th
width of the gate image (and therefore the width of the "zone"
test specimen subjected to examination) changes in jump steps
Then adjust the vernier on the LENGTH control and observe t
it will continuously adjust the gate image width between the st
created by the pointer.

the gate multivibrators which produce a square wave (start and width controlled by START and LENGTH controls on front panel). This wave produces the gate image on the CRT and at the same time gates the video amplifier on the ECHO GATE which permits any video (echo pulses) which may be present from the specimen coincident with the gate to be passed to the RECORDER board.

The RECORDER board accepts the gated video and produces a DC level proportional to the amplitude of the largest signal in the gate. This DC is sent out via the R or S chassis to drive penmotor type recorders. It is also used to trigger a binary circuit (under control of the LEVEL adjustment) in the RECORDER - the on-off signal so produced is used to drive ALFAX type recorders and is also sent to the ALARM board to actuate the audio and visual alarm circuitry.

The ALARM board accepts the alarm signals from the RECORDER board (through front panel controls) and functions as an "automatic reset" oneshot or a "manual" flip-flop and drives the internal light and buzzer alarms.

The INTERFACE SYNC board accepts video from the UM Reflectoscope and after a delay which blanks out the "main bang" permits the first echo (from entrant face) to generate a trigger which is sent to the ECHO GATE to synchronize the gating circuitry. The marker shift circuits also generate a trigger which is used (if the Time Control MARKER control is in IF position) to synchronize the marker generator in the Time Control so that the markers can be moved in respect to the video trace.

The front and rear panel assembly contains the various external controls and the jacks and connectors for interconnecting the Transigate and for providing output alarm and print signals.

In the following detailed discussion of the circuitry, reference should be made to the overall schematic of the Transigate unit.

2. ECHO GATE 50C384

The Sync #2 square wave generated by the timer in the UM Reflectoscope is connected to pin 4, J201 via pin 13, J101 and is differentiated and clamped at

(4) By manipulating the GATE controls, SYNC controls, and the cc on the UM Reflectoscope, it should be possible to achieve a pro tation similar to that shown in Figure 9-2.

(5) With the MARKER control on the Time Control Unit in IF positi adjust the MARKER SHIFT vernier (on the SYNC control) and ob that the markers can be positioned relative to the video trace w changing the marker frequency (Figure 9-2).

(6) Next manipulate the GAIN control on the Pulser Receiver to var amplitude of the echo in the gate and at the same time adjust th vernier LEVEL control on the Transigate and observe that the RESET light and buzzer (if the AUDIO switch is ON) can be acti at various predetermined levels of echo signal. Also move the to + and - AUTO positions and note that in the + position the ala are actuated when the echo signal exceeds the set level and that the - position a decrease in signal achieves the same effect; als the alarms reset automatically. The + and - MANUAL positions the same effect except that the alarms have to be reset by pushi the RESET light.

(7) If a Type S Recording Amplifier or a Type R Relay Chassis is being used, consult their operating instructions and observe that they react properly at the same time that the alarms are actuated

d. TESTING

The gate should be set up according to the above using a test specime (a "standard") similar to those for which continuous monitoring is desired. As the specimens are passed by the search unit all will be monitored in respect to the same zone and appropriate alarm or recording devices will be actuated in instances where deviations exist

PRINCIPLES OF OPERATION

1. GENERAL

Figure 9-3 is a block diagram of the Transigate unit. The ECHO GATE receives a trigger from the Time Control Unit coincident with the main puls or from the INTERFACE SYNC board coincident with the first echo dependi upon the position of the SYNC control on the front panel. This trigger actua

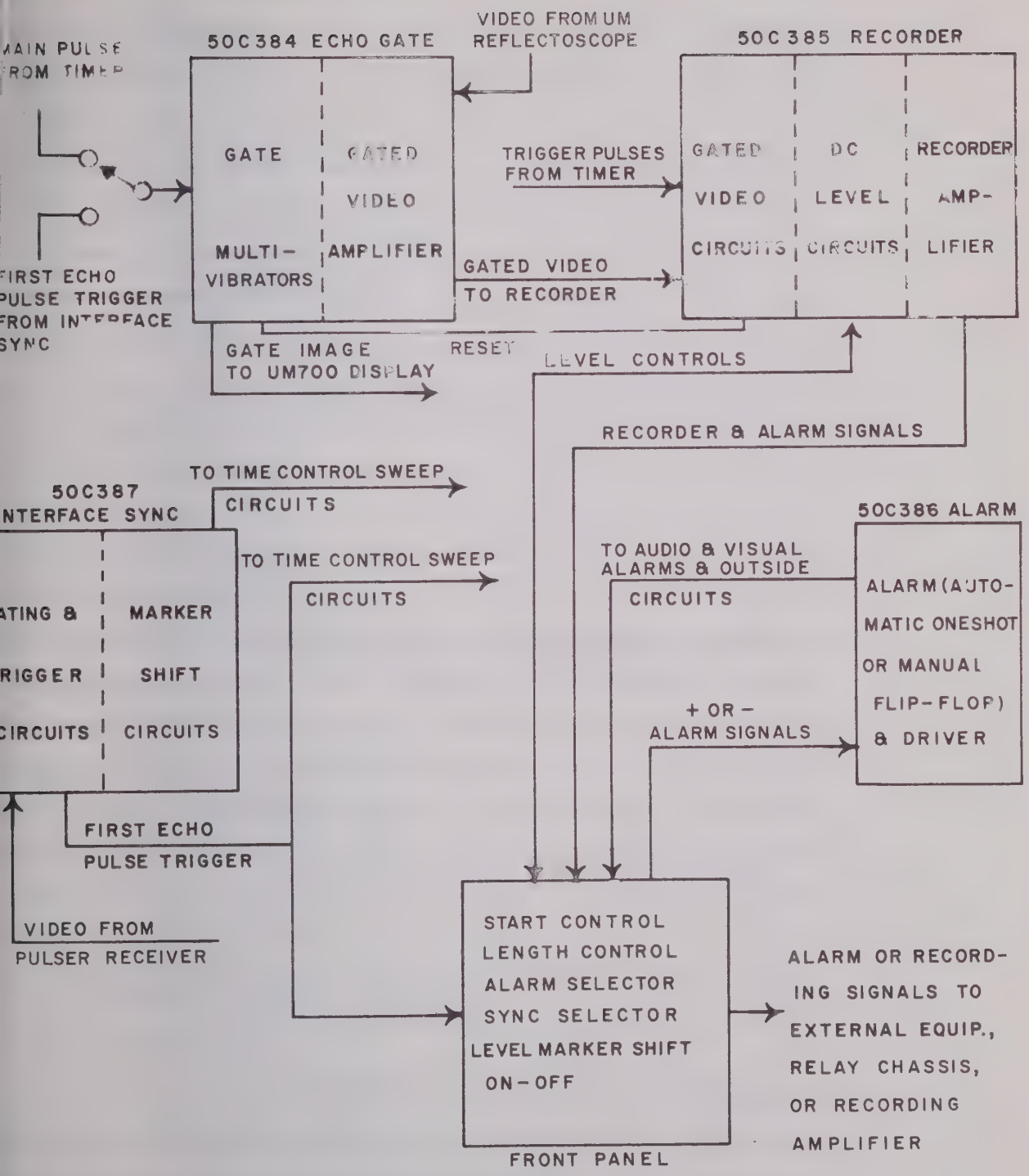


Figure 9-3
Block Diagram of Transigate Unit

C201, R201 and CR201. Q201 affords a low impedance trigger source for following circuits. When the front panel SYNC switch is set at MAIN PULS this trigger source is connected to pin 6, J201.

Q205 and Q206 comprise a monostable or oneshot multivibrator. The positi trigger pulse is amplified and inverted regeneratively by Q205. The resulti negative trigger couples the charge across C105, C106, C107 or C108 (depending on switch position). CR205 prevents excess current from flowin in the base of Q206. CR205 disconnects the emitter base junction of Q206 fr timing circuit to aid temperature stability. The output square pulse is diffe entiated and clamped through C206, R218, and CR206 and coupled through (into the "length oneshot" monostable multivibrator, Q207, Q208, and Q209. Q208 provides a low impedance driving source for the timing network and g circuit while at the same time preventing, by virtue of its relatively high in impedance, the waveform at collector Q207 from being degraded. The posi going square pulse is used to display the gate image on the cathode ray tube via pin 12, J201. CR207 becomes a part of a diode "or" gate when more tha one ECHO GATE board is used. CR209 and CR208 perform the same functi as CR205 and CR204 above. The emitter of Q208 also drives a two transist "and" gate consisting of Q204 and Q202. These transistors are in series. Q can only amplify and invert the video coming from pin 19, J201 when Q204 conducting fully. Q204 is conducting fully only when the gate is being gener CR202 sets the proper voltage level on the incoming video to match the inpu Q202. This provides DC coupling to maintain good linearity of gated video regardless of signal level conditions. R208 is the range control and adjusts amplitude of the pedestal voltage that occurs during the gate period. This pedestal voltage sets the proper operating level for the following circuitry. adjusts the gain of the gated amplifier Q202.

3. RECORDER BOARD 50C385

Gated video from the ECHO GATE board enters at pin 8, J301. Q301 provid power gain to charge C301 through CR301 to near the video peak value. The gated video through Q301 is negative going and changes the voltage level at 4 of V301 from a quiescent 12 volts to the negative going peak value of the incoming gated video. The reverse slope of the video is disconnected from

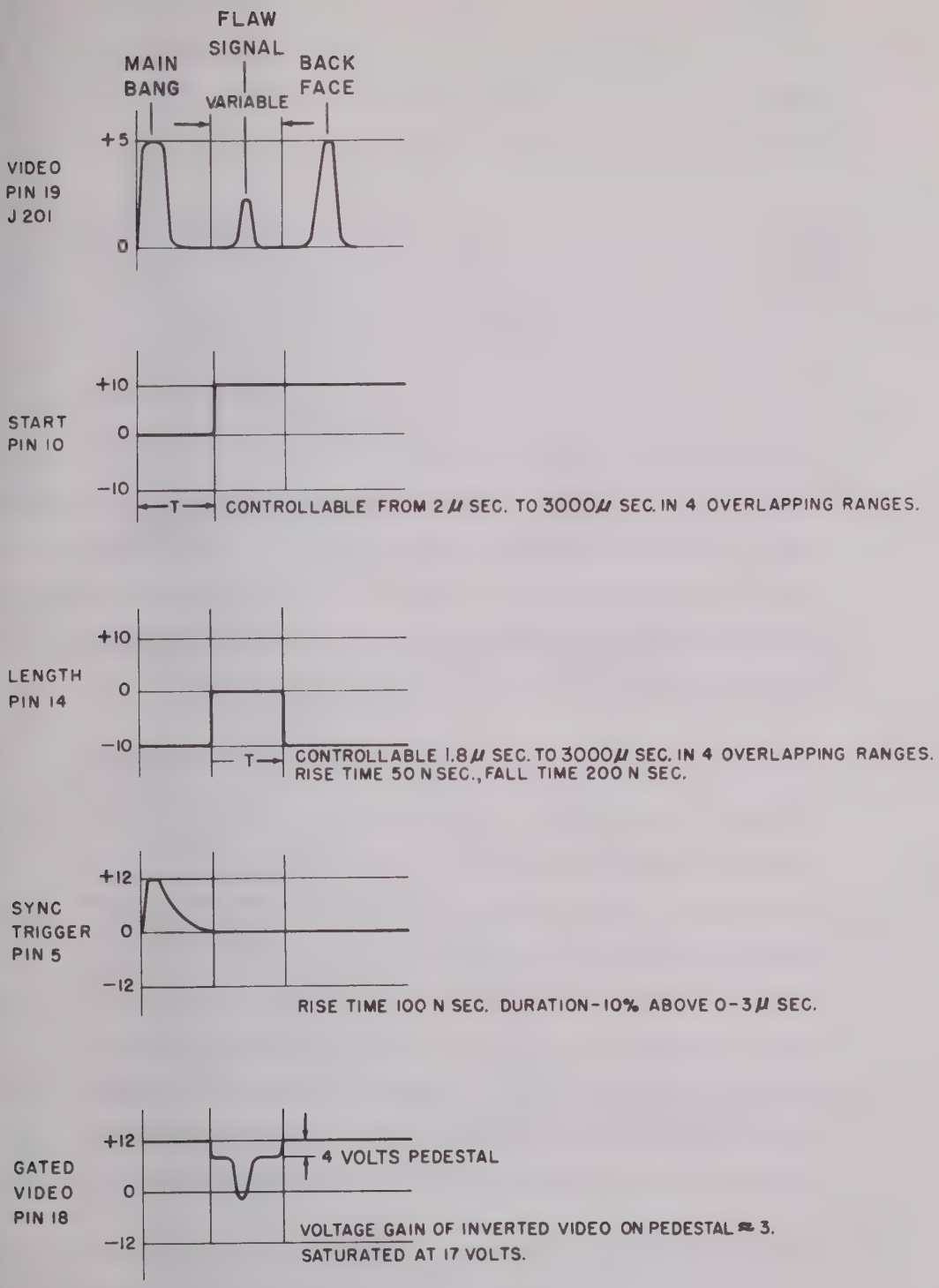


Figure 9-4
Echo Gate Waveforms

by diode CR301. This leaves the peak voltage charge on C301 which is al
p:esent at pin 4, V301. By cathode follower, (V301) this new voltage lev
transferred to pin 8, V301. There is also the same quiescent 12 volt leve
pin 4, V302. The new level at pin 8, V301 is now transferred to pin 4, V
through CR303 diode. C308 is now at this new level. This all occurs duri
first half cycle of the timer sync wave form.

At the half cycle interval of the sync wave form, a trigger pulse is deriv
pin 10, J301. Q306 affords power gain to drive reset amplifier Q302. Th
pulse, positive going, recharges C301 back to its initial -12 volt quiesce
via CR302. This level is again transferred to pin 8, V301. This time, ho
CR303 is reverse biased and allows the original charge to be kept on C30
This capacitor now remembers the peak value of the last gated video pul
because of the very long time constant involved. The next main bang now
occurs. If the new gated video coming from pin 8, J301 is greater in amp
tude than the charge on C308, then both C301 and C308 will reach this ne
level. If the new level coming from pin 8 is of a lower amplitude, then o
C301 is charged to its new level without affecting C308.

At the end of the gate a reset trigger pulse is derived from pin 19, J301,
is shaped and fed to reset amplifier Q307. The positive going pulse at th
collector of Q307 connects CR304 and recharges C308 to +12 volt level b
because this is a short pulse, CR304 quickly disconnects while CR303 in
connects and puts the "new peak" video level on C308. Thus the voltage
pin 8, V302 varies in step intervals with its level proportional and appro
equal to the peak value of the gated video. If the gated video level is con
voltage level at pin 8, V302 is constant. If only one video pulse should e
a square pulse proportional to the height of the video pulse and equal to
between the gated video and the end of the next gate will be presented.

CR102 on the LEVEL control maintains a constant DC level across R110
varies the amount of reverse bias on Q303. Any signal in addition to this
bias must be great enough to make Q303 conduct. Proper rotation of the
will achieve this as will a changing voltage caused by incoming gated vid

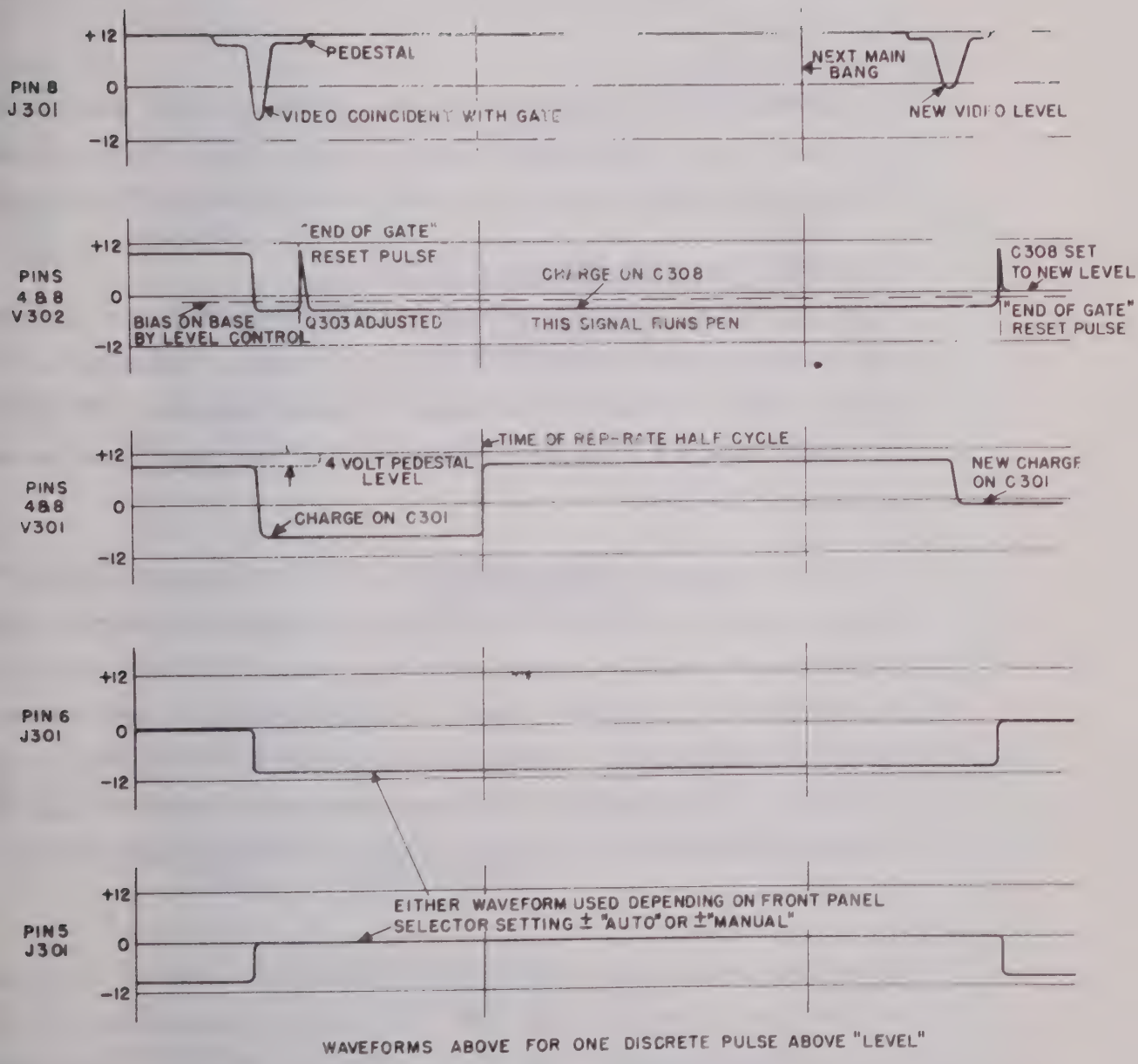


Figure 9-5
Recorder Waveforms

8, J301. When Q303 does conduct, it affords power gain to make Q304, Q305 ("recorder amplifier") trip. Q304 and Q305 can only be in one of two conditi When the collector of Q304 is at -10 volts, the collector of Q305 must be at g potential and vice versa, so that when a gated video signal is great enough to overcome the controllable reverse bias on Q303, Q303 conducts making Q304 Q305 trip. As soon as the video disappears from the gate, they will go back t their original state.

By choosing the proper point (pin 6 or pin 5, J301), a negative signal is deriv for either rising or falling gated video. This signal voltage will be present o when incoming gated video is greater than the setting of the LEVEL control b

4. INTERFACE OR FIRST ECHO SYNC 50C387

Q506 and Q507 form the major components of a transistor oneshot multivibra The collector of Q507 is normally near ground potential. This allows Q501 to as an amplifier inverter for video signals incoming from pin 4, J501. Q501 i this condition only between the end of delay of the "gate oneshot" and the adve of the next video pulse.

A concurrent trigger, positive going, from pin 5, J501 occurs during the "m bang" time and sets the "gate oneshot" Q506-Q507 into its quasi-stable state. duration of this condition depends on the time constant of R504 times C501. V the oneshot is in its temporary state, the collector Q507 is at approximately volts. This cuts off Q501 so that any incoming video will not be passed to Q5 Q503 binary. During the delay time being generated by Q506-Q507 "gate ones flip-flop Q502-Q503 was set into one state by the same pulse that initiated the "gate oneshot".

After the delay has run its course in the "gate oneshot", Q501 is then turned so that it may amplify incoming video. The first video pulse that enters after delay is amplified in Q501 which in turn resets the "IF flip-flop" Q502-Q503. the advent of this reset time, a pulse is sent through a shaper network and in trigger amplifier Q508 which in turn sends the pulse to the sweep generator. other video that may follow will no longer have any effect on the "IF flip-flop" that no further trigger pulses to the sweep generator will come from this sou

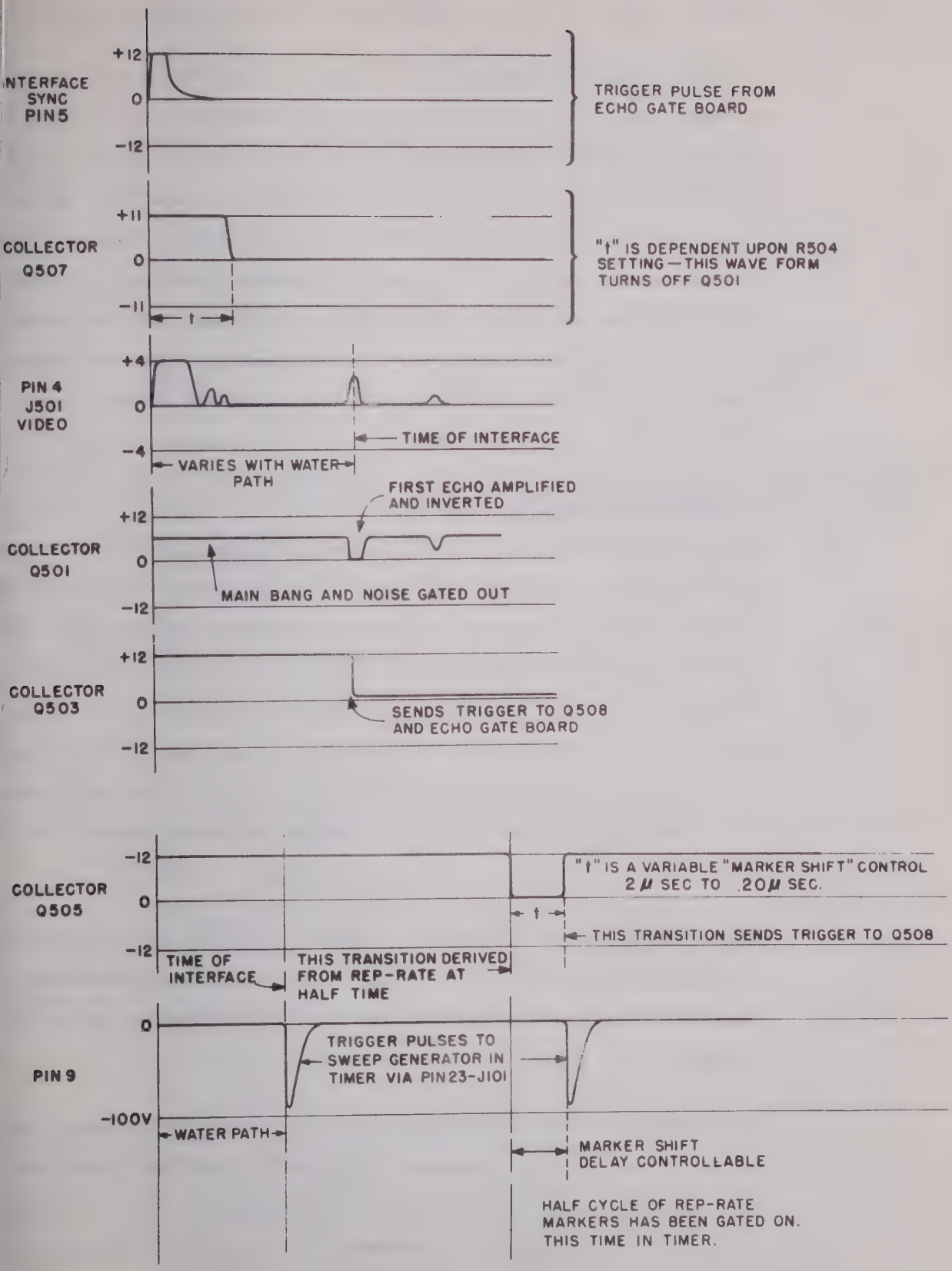


Figure 9-6
Interface Sync Waveforms

until after the next "main bang" and delay. The start of the sweep will be with the first echo after the "main bang" which presumably is an

Another monostable multivibrator (Q504-Q505) presents a delay time and to Q508. This triggers the sweep generator during the next half cycle of waveform coming from the timer. At that time the beam has been reposi and the markers gated on, but no sweep is generated until C505 and R111 and R113 (front panel MARKER SHIFT control) has been satisfied. This p the markers in relation to the video sweep without changing the marker f When the Timer controls and Transigate controls have been set properly echo sync and the "repetition rate", "sweep generator" and "marker shif control settings do not conflict, the marker sweep will always be present on the CRT.

5. ALARM BOARD 50C386

When S103 (ALARM switch on front panel) is in either plus (+) or minus(- AUTO position, Q401-Q402 are connected as a transistor oneshot multivi tor with a quasi-stable duration of approximately 152 milliseconds. With in AUTO position and no video in the gate on the CRT above the LEVEL c setting, there will be a negative 10 volts present at pin 7, J401. If this is short negative pulse (one single video pip in a long time) CR404 will con this short pulse (which is always at least one rep-rate cycle long) to the shot which in turn will generate a 152 millisecond output through Q403 "E driver".

If the video in the gate is continual, CR404 will remain connected because is a continuous negative signal at pin 7, J401. Even though the oneshot ti constants have run down, the multivibrator will not reset as long as pin 7 negative.

When S103 is in ± MANUAL RESET position, Q401-Q402 becomes a flip-f whose "armed" or "set" condition is Q401 "off", Q402 "on". When pin 7 t negative CR404 connects and turns Q401 "on" and Q402 "off". This condit will remain regardless of what happens at pin 7; this is a continuous cond and can only be reset by closing S105 contacts manually.

The output from the ALARM board turns on transistor Q101 on the rear panel which actuates lamp DS103 and the buzzer if the AUDIO SWITCH, S106, is on. A signal is also present at pin 4, J401, for external purposes.

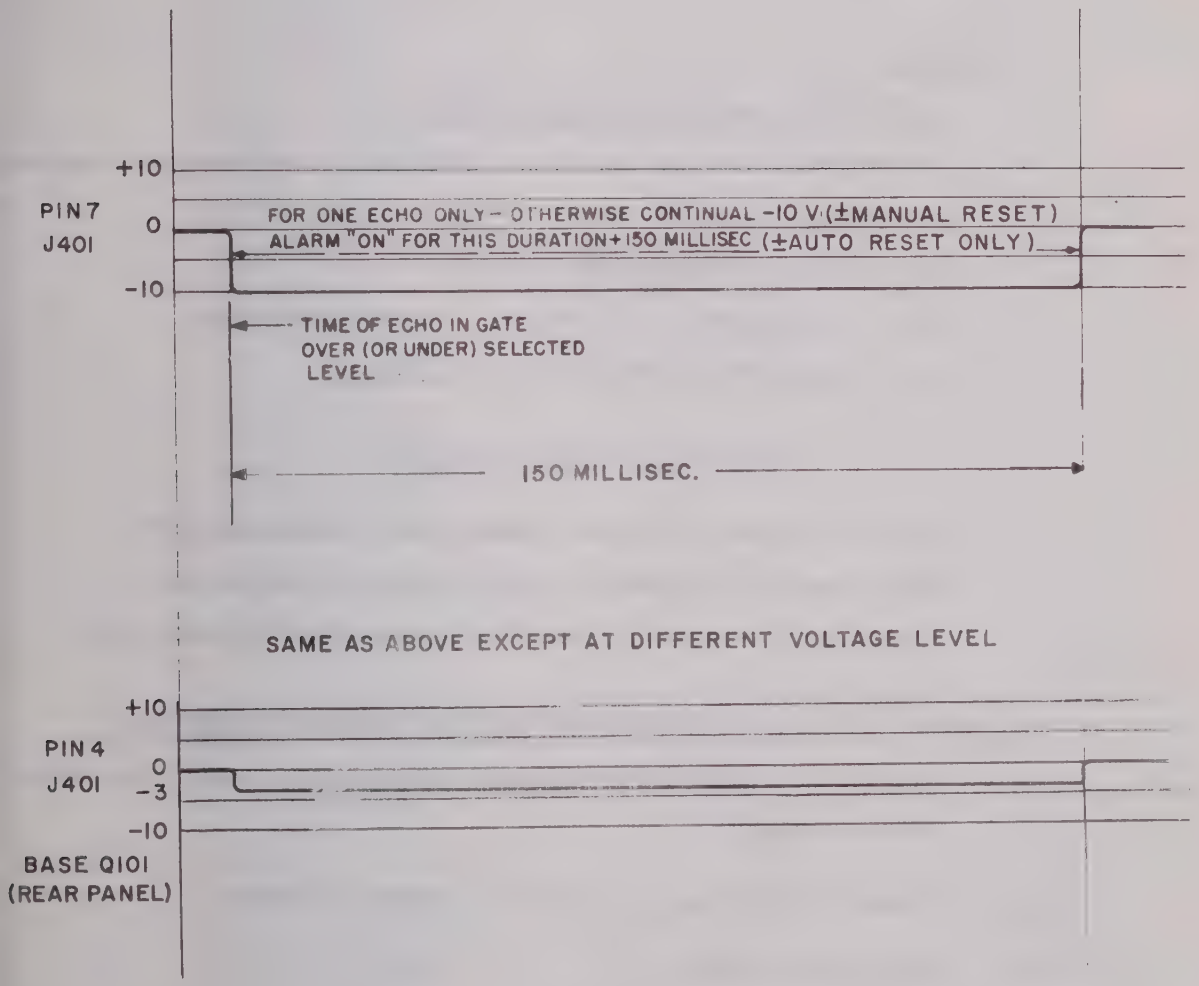


Figure 9-7
Alarm Board Waveforms

WARNING

NEVER CONNECT OR DISCONNECT
TRANSISTORIZED PLUG-IN UNITS
OR P.C. BOARDS WHEN UM
REFLECTOSCOPE IS "ON".

1. GENERAL

a. TEST AND ASSOCIATED EQUIPMENT

The following test and associated equipment is required for checking the Transigate:

(1) Servistension style 50C495.

(2) Tektronix 531 or equivalent, recently calibrated.

(3) Simpson Model 260, recently calibrated.

PERSONAL SAFETY WARNING

Lethal voltages are present - always turn instrument OFF when changing components. Always keep one hand in clear when making temporary connections (connecting test leads, etc.).

2. TRANSIGATE 50E550 CHASSIS INSPECTION AND MEASUREMENT

a. Inspect chassis for loose or broken connections, loose components, s of overheating etc.

b. Rotate all front panel controls full counter-clockwise.

c. Turn AUDIO switch off.

d. Turn GATE switch off.

e. Use Servistension and turn Transigate unit on. At printed circuit boa connectors measure voltages below using Simpson 260 or equivalent.

CHART 1

TRANSIGATE VOLTAGE MEASUREMENTS

1	+11.8 vdc	1	+11.8 vdc	1	1	+11.8 vdc	1	+11.8 vdc
2	-11.8 vdc	2	-11.8 vdc	2	2	-11.8 vdc	2	-11.8 vdc
3	0	3	0		3	0	3	0
4	+5.4 v	4	+144 v		4	-.2 v	4	-11.6 v
5	.2 v	5	0		5	+3.7 v	5	
6	-10 v	6	-10 v		6	+.6 v	6	0
7	+128 v	7	+11.8 v		7	0	7	-2.2 v
8		8	+1.v		8	+3.7 v	8	+11.8 v
9	0	9			9		9	
10		10			10	+12	10	+144 v
11		11			11		11	+150 v
12		12	-11.8 v		12		12	
13		13	-11.8 v		13		13	
14		14	0		14		14	0
15		15	-1.1 v		15		15	0
16		16			16		16	+10.7 v
17	-104 vdc	17	-104 vdc		17		17	-104 v
18	0	18	+11.8 v		18		18	-1.8 v
19	+1.1 v	19	+.5 v		19		19	-11.8 v
20	0	20			20		20	
J501 IF Board		J201 Echo Gate			J401 Record		J301 Alarm	

(VIEW OF CONNECTORS FROM BOTTOM)

TRANSIGATE UNIT

CONTROL	SETTINGS	CONTROL	SETTINGS
SYNC	MAIN PULSE OR FIRST ECHO	AUDIO SWITCH	ON
		GATE SWITCH	ON
MARKER SHIFT	MID RANGE	START POINTER	1
ALARM		START VERNIER	MID RANGE
LEVEL	MID RANGE	LENGTH POINTER	1
SELECTOR	+ AUTO	LENGTH VERNIER	MID RANGE

TRANSIGATE UNIT IRREGULAR OR INOPERATIVE

Check that unit is properly in place, UM Reflectoscope is operating properly, cables are connected and firmly seated, controls on Transigate are properly set.

Remove Transigate and visually inspect for loose or missing transistors, poor connections on wires or components, burned components, or other obvious trouble.

Check voltage according to Chart 1

No gate image on CRT

- Check gate switch
- Gate length too long for pulse rate
- Check transistors and waveshapes (figure 9-4) at echo gate board

No alarm actuation or recording signals

- No signal in gate on + operation, or large signal in gate on - operation.
  - Check alarm devices
  - Check transistors and waveshapes (figure 9-5) on recorder board
  - Check transistors and waveshapes (figure 9-7) on alarm board

No sweep on Display unit in first echo sync position

- Time Control Marker switch not in I. F. position
- Time Control sweep delay switch on
- Check transistors and waveshapes (figure 9-6) on I. F. sync board.

PARTS LIST

TRANSIGATE UNIT - STYLE 50E550

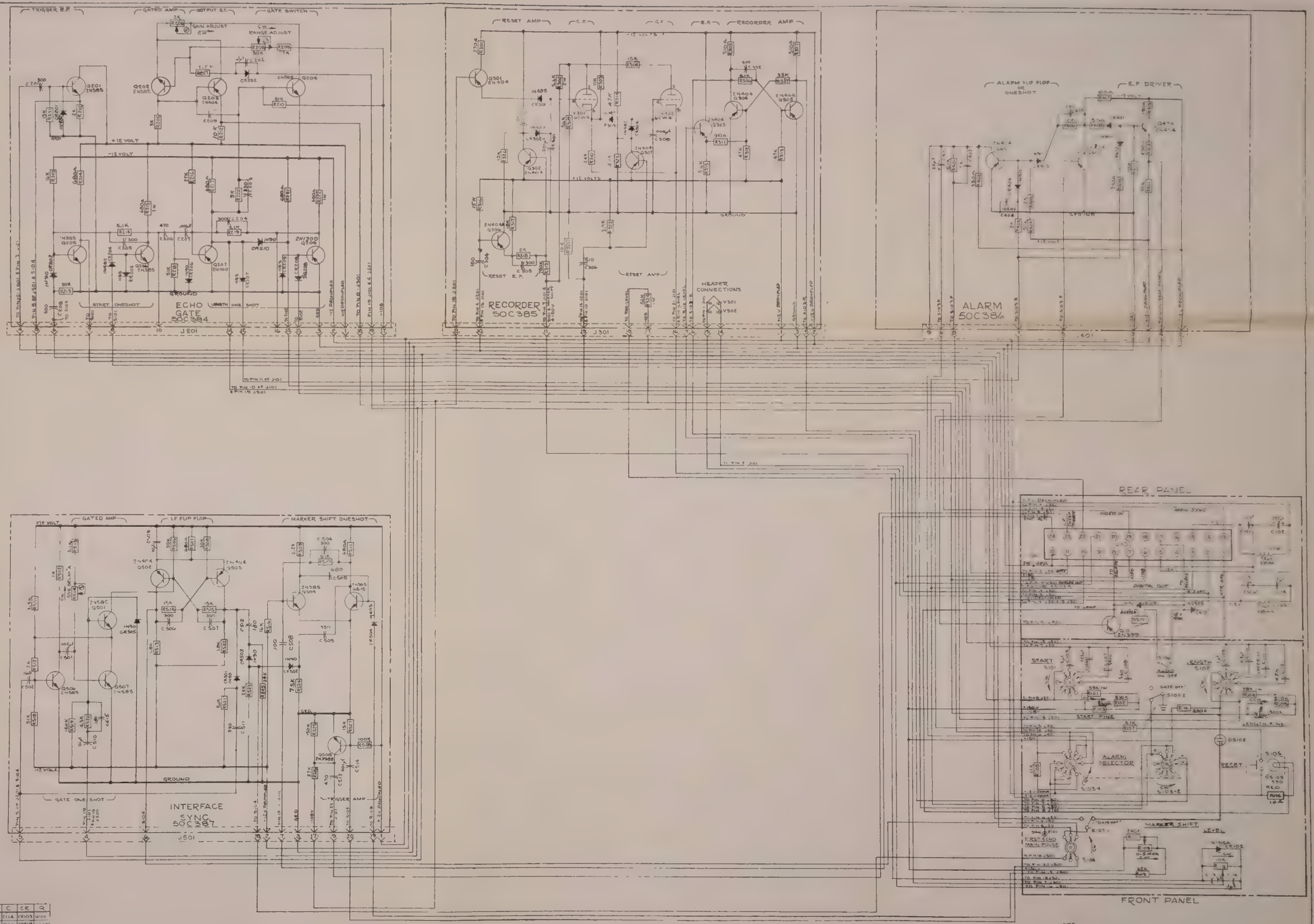
Reference Schematic 50E550

Schematic Symbol No.	Sperry Part No.	Description
C101	DQG002A04	Capacitor 1 uf
C102	DQL001A22	Capacitor 250 uf
C103	DQL001A22	Capacitor 250 uf
C104	DQG002A04	Capacitor . 1 uf
C105	Avco Electric	Capacitor . 15 uf 100 vdc 1DP-3-154
C106	Avco Electric	Capacitor . 025 uf 100 vdc 1DP-1-253
C107	Avco Electric	Capacitor 3900 uuf 500 vdc DM-20-392
C108	DQB009B21	Capacitor 560 uuf
C109	Avco Electric	Capacitor . 1 uf 100 vdc 1DP-2-104
C110	Avco Electric	Capacitor . 015 uf 400 vdc 4DP-1-153
C111	Avco Electric	Capacitor . 0025 uf 600 vdc 6DP-1-252
C112	DQB009B18	Capacitor 470 uuf 500 vdc ±5%
C113	Centralab	Capacitor . 1 uf DA-104
C114	Centralab	Capacitor . 1 uf DA-104
CR101	IN2525	Diode
CR102	IN1315A	Diode
CR103	IN90	Diode
R101	DPA006D15	Resistor 39K 1W 5%
R102	DPA004E18	Resistor 510 K 1/2 W 5%
R103	Part of 50B804	Potentiometer 500K
R104	DPA006D15	Resistor 39K 1 W 5%
R105	DPA004E18	Resistor 510 K 1/2 W 5%
R106	Part of 50B804	Potentiometer 500K
R107	DPA004C18	Resistor 5. 1K 1/2 W 5%
R108	DPA004D02	Resistor 11K 5%
R109	Part of 50B803	Potentiometer 0. 5 Meg
R110	Part of 50B805	Potentiometer 10K
R111	DPA004E10	Resistor 240K 1/2 W
R112	Not Used	
R113	DPA004D20	Resistor 62K 1/2W
R114	DPA005E07	Resistor 330K 1/2W
Q101	2N399	Transistor
DS101	Line Electric	Buzzer Series MD 6 vac
DS102	NE2	Lamp Neon
DS103	330	Lamp
S101	Part of 50B804	Switch Rotary
S102	Part of 50B804	Switch Rotary
S103	Part of 50B805	Switch Rotary
S104	Part of 50B803	Switch Rotary
S105	50A2557	Switchlite
S106		Switch Slide SPST
S107		Switch Slide DPST
J101	CQC017P01	Plug
J201	Elco	Connector PCU420B
J301	Elco	Connector PCU420B
J401	Elco	Connector PCU420B
J501	Elco	Connector PCU420B
L101	J. W. Miller	RF Choke 4626
L102	J. W. Miller	RF Choke 4626
E101	C. T. C.	Terminal
	50B803	Resistor and Switch Assembly (R109, S104)
	50B804	Resistor and Switch Assembly (R103, R106, S101, S102)
	50B805	Resistor and Switch Assembly (R110, S103)
	50C384	Echo Gate P. C. Board Assembly
	50C385	Recorder P. C. Board Assembly
	50C386	Alarm P. C. Board Assembly
	50C387	I. F. Sync. P. C. Board Assembly
	Raytheon	Knob 70-ICB-2G
	Raytheon	Knob 50-4-1G

Schematic Symbol No.	Sperry Part No.	Description
	Southco	Fastener 48-10-102-10
	Bendix	Transistor Socket 210-6500
	00A078	Nameplate
		50C384 ECHO GATE P. C. BOARD
C201	DQB005B45	Capacitor 500 uuf
C202	Sprague	Capacitor . 1 uf 25 vdc 5C7
C203	DQB006B43	Capacitor 680 uuf
C204	DQB005B39	Capacitor 300 uuf
C205	DQB005B39	Capacitor 300 uuf
C206	DQB005B44	Capacitor 470 uuf
C207	Erie	Capacitor .001 uf BP861
C208	DQB005B45	Capacitor 500 uuf
C209	Centralab	Capacitor 68 uuf 1000 vdc ID-680
CR201	IN90	Diode
CR202	IN1314A	Zener Diode
CR203	IN482	Diode
CR204	IN482	Diode
CR205	Hoffman	Diode HB3
CR206	IN90	Diode
CR207	Hoffman	Diode HB3
CR208	Transitron	Diode SG228
CR209	Hoffman	Diode HB3
R201	DPA004D05	Resistor 15K 1/2W ±5%
R202	DPA004C08	Resistor 2K 1/2W ±5%
R203	DPA004D06	Resistor 16K 1/2W ±5%
R204	DPA004B21	Resistor 680 ohms 1/2W ±5%
R205	DPA004C12	Resistor 3K 1/2W ±5%
R206	Bourns	Potentiometer 2K 275-1-202
R207	DPA004C01	Resistor 1K 1/2W ±5%
R208	Bourns	Potentiometer 50K 276-1-503
R209	DPA004D17	Resistor 47K 1/2W ±5%
R210	DPA004D18	Resistor 51K 1/2W ±5%
R211	DPA004D02	Resistor 11K 1/2W ±5%
R212	DPA004D18	Resistor 51K 1/2W ±5%
R213	DPA004D12	Resistor 30K 1/2W ±5%
R214	DPA004C18	Resistor 5.1K 1/2W ±5%
R215	DPA007B11	Resistor 680 ohms 1W ±5%
R216	DPA004D11	Resistor 27K 1/2W ±5%
R217	DPA004B21	Resistor 680 ohms 1/2W ±5%
R218	DPA004D18	Resistor 51K 1/2W ±5%
R219	DPA004C18	Resistor 5.1K 1/2W ±5%
R220	DPA004C07	Resistor 1.8K 1/2W ±5%
R221	DPA004B21	Resistor 680 ohms 1/2W ±5%
R222	DPA007B11	Resistor 680 ohms 1W ±5%
Q201	2N585	Transistor
Q202	2N585	Transistor
Q203	2N404	Transistor
Q204	2N585	Transistor
Q205	2N385	Transistor
Q206	2N385	Transistor
Q207	2N1300	Transistor
Q208	2N585	Transistor
Q209	2N404	Transistor
	Elco	Transistor Socket 3303
	50B809	Echo Gate P.C. Board Sub-Assembly
		50C385 RECORDER P.C. BOARD
C301	Avco	Capacitor .001 uf 600 vdc 60P-1-102
C302	DQB005B39	Capacitor 300 uuf
C303	Not Used	
C304	DQB005B33	Capacitor 180 uuf
C305	DQB005B39	Capacitor 300 uuf
C306	Erie	Capacitor 510 uuf ED-510

Schematic Symbol No.	Sperry Part No.	Description
C307	Centralab	Capacitor .02 uf 150 vdc DDM-203
C308	Avco	Capacitor .004 uf 600 vdc 6DP-1-402
CR301	IN485	Diode
CR302	IN485	Diode
CR303	IN485	Diode
CR304	IN485	Diode
CR305	IN90	Diode
R301	DPA005B06	Resistor 270 ohms 1/2W ±5%
R302	DPA008C119	Resistor 5.6K 2W
R303	DPA004D02	Resistor 11K 1/2W ±5%
R304	DPA004D05	Resistor 15K 1/2W ±5%
R305	DPA004B18	Resistor 510 ohms 1/2W ±5%
R306	DPA004C24	Resistor 9.1K 1/2W ±5%
R307	DPA004B18	Resistor 510 ohms 1/2W ±5%
R308	DPA004D04	Resistor 10K 1/2W ±5%
R309	DPA004D19	Resistor 56K 1/2W ±5%
R310	DPA004D10	Resistor 24K 1/2W ±5%
R311	DPA004B24	Resistor 910 ohms 1/2W ±5%
R312	DPA004D17	Resistor 47K 1/2W ±5%
R313	DPA004D17	Resistor 47K 1/2W ±5%
R314	DPA004D04	Resistor 10K 1/2W ±5%
R315	DPA005C10	Resistor 5.6K 1/2W ±5%
R316	DPA004E05	Resistor 150K 1/2W ±5%
R317	DPA004C07	Resistor 1.8K 1/2W ±5%
R318	DPA004C08	Resistor 2K 1/2W ±5%
R319	DPA004E22	Resistor 750K 1/2W ±5%
R320	DPA004C15	Resistor 3.9K 1/2W ±5%
R321	DPA004D10	Resistor 24K 1/2W ±5%
R322	DPA004D04	Resistor 10K 1/2W ±5%
R323	DPA004E23	Resistor 820K 1/2W ±5%
R324	DPA007D10	Resistor 56K 1/2W ±5%
R325	DPA004D04	Resistor 10K 1/2W ±5%
R326	DPA004D04	Resistor 10K 1/2W ±5%
R327	DPA004D13	Resistor 33K 1/2W ±5%
Q301	2N404	Transistor
Q302	2N404	Transistor
Q303	2N404	Transistor
Q304	2N404	Transistor
Q305	2N404	Transistor
Q306	2N404A	Transistor
Q307	2N404	Transistor
V301	6CW4	Tube
V302	6CW4	Tube
	Elco	Transistor Socket 3303
	Cinch-Jones	Tube Socket 133 65101001
	50B807	Recorder P.C. Board Sub-Assembly
	50C386 ALARM P.C. BOARD	
C401	Cornell-Dubilier	Capacitor 20 uf 25 vdc NL-20-25
C402	DQB005B36	Capacitor 240 uuf
C403	DQB005B36	Capacitor 240 uuf
C404	Sprague	Capacitor .05 uf 50 vdc 55C23
CR401	IN90	Diode
CR402	IN90	Diode
CR403	IN90	Diode
CR404	IN90	Diode
R401	DPA004C18	Resistor 5.1K 1/2W ±5%
R402	DPA004B13	Resistor 330 ohms 1/2W ±5%
R403	DPA004C08	Resistor 2K 1/2W ±5%
R404	DPA004C18	Resistor 5.1K 1/2W ±5%
R405	DPA004C08	Resistor 2K 1/2W ±5%
R406	DPA004C08	Resistor 2K 1/2W ±5%
R407	DPA004B18	Resistor 510 ohms 1/2W ±5%
R408	DPA004B18	Resistor 510 ohms 1/2W ±5%
R409	DPA004B18	Resistor 510 ohms 1/2W ±5%
R410	DPA004D21	Resistor 68K 1/2W ±5%

Schematic Symbol No.	Sperry Part No.	Description
R411	DPA004D01	Resistor 10K 1/2W ±5%
R412	DPA004B08	Resistor 200 ohms 1/2W ±5%
R413	DPA004B05	Resistor 150 ohms 1/2W ±5%
Q401	2N404	Transistor
Q402	2N404	Transistor
Q403	2N404	Transistor
	Elco	Transistor Socket 3303
	50B808	Alarm P.C. Board Sub-Assembly
	50C387 INTERFACE SYNC P.C. BOARD	
C501	Avco	Capacitor .002 uf 600 vdc 6DP-1-202
C502	DQB005B32	Capacitor 160 uuf
C503	Centralab	Capacitor .02 uf 30 vdc DA-203
C504	DQB005B39	Capacitor 300 uuf
C505	Avco	Capacitor 680 uuf 100 vdc CM-15-E-681J
C506	DQB005B39	Capacitor 300 uuf
C507	DQB005B39	Capacitor 300 uuf
C508	DQB005B18	Capacitor 47 uuf
C509	DQB005B40	Capacitor 330 uuf
C510	Erie	Capacitor .01 uf 100 vdc ET8805
C511	DQB005B40	Capacitor 330 uuf
C512	DQB005B33	Capacitor 180 uuf
C513	DQB005B44	Capacitor 470 uuf
C514	Erie	Capacitor .001 uf 500 vdc BP861
C515	DQB005B33	Capacitor 180 uuf
CR501	IN90	Diode
CR502	IN90	Diode
CR503	IN90	Diode
CR504	IN485	Diode
CR505	IN90	Diode
R501	DPA004C13	Resistor 3.3K 1/2W ±5%
R502	DPA004C01	Resistor 1K 1/2W ±5%
R503	DPA004C18	Resistor 5.1K 1/2W ±5%
R504	Bourns	Potentiometer 50K 276-1-503
R505	Not Used	
R506	DPA004D12	Resistor 30K 1/2W ±5%
R507	DPA004B21	Resistor 680 ohms 1/2W ±5%
R508	DPA004D12	Resistor 30K 1/2W ±5%
R509	DPA004C09	Resistor 2.2K 1/2W ±5%
R510	DPA004C18	Resistor 5.1K 1/2W ±5%
R511	DPA004B21	Resistor 680 ohms 1/2W ±5%
R512	DPA004D03	Resistor 12K 1/2W ±5%
R513	DPA004C07	Resistor 1.8K 1/2W ±5%
R514	DPA004D05	Resistor 15K 1/2W ±5%
R515	DPA004D05	Resistor 15K 1/2W ±5%
R516	DPA004D06	Resistor 16K 1/2W ±5%
R517	Not Used	
R518	DPA004D18	Resistor 51K 1/2W ±5%
R519	DPA004E03	Resistor 120K 1/2W ±5%
R520	DPA004C16	Resistor 4.3K 1/2W ±5%
R521	DPA004C18	Resistor 5.1K 1/2W ±5%
R522	DPA004C07	Resistor 1.8K 1/2W ±5%
R523	DPA004D10	Resistor 24K 1/2W ±5%
R524	DPA004D10	Resistor 24K 1/2W ±5%
R525	DPA004E05	Resistor 150K 1/2W ±5%
R526	DPA004D11	Resistor 27K 1/2W ±5%
R527	DPA004D05	Resistor 15K 1/2W ±5%
R528	DPA004E01	Resistor 100K 1/2W ±5%
Q501	2N585	Transistor
Q502	2N404	Transistor
Q503	2N404	Transistor
Q504	2N385	Transistor
Q505	2N385	Transistor
Q506	2N585	Transistor
Q507	2N585	Transistor
Q508	2N398	Transistor
	Elco	Transistor Socket 3303
	50B806	Interface Sync P.C. Board Sub-Assembly



	R	C	CR	Q
LAST USED	R518	C514	CR103	Q101
	R522	C515	CR210	Q209
	R527	C508	CR504	Q502
	R43	C509	CR506	Q503
	R52	C518	CR508	Q505
				Q208
NOT USED				
	R523	C517		
	R517			

NOTE
EXCEPT AS NOTED
ALL RESISTORS ARE ½ WATT ± 5%
ALL CAPACITORS ARE μf
ALL SWITCHES VIEWED FROM REAR

		SPERRY PRODUCTS COMPANY	
		TRANSGATE E850	
		SCHEMATIC	
		50E529	
		50E529	

SECTION X

TYPE S RECORDING AMPLIFIER

DESCRIPTION

1. GENERAL

The Type S Recording Amplifier incorporates two separate channels which enables it to accept information from one or two Transigates. Each channel provides outputs for direct operation of external recorders, solenoids, alarms, and controls with no intermediate amplifiers required. The unit is designed to fit into either of two rear compartments in the Special Function Cabinet. When it is firmly seated in the Cabinet it makes automatie contact with the Transigates (mounted in the front compartments of the Special Function Cabinet) through mating connectors. The Amplifier consists of the following major components:

Figure 10-1
Type S Recording Amplifier

a. RELAY

Under control of UM Reflectoscope, acts as power ON-OFF switch for Recording Amplifier.

b. CONTROL RELAYS

One for each channel; controlled by alarm signals from Transigate; control contacts at output for external equipment.

c. ALFAX PRINTING CHANNEL

One for each channel; provides DC drive voltage control and limiting for facsimile recorders.

d. POWER SUPPLY AND REGULATOR

One per unit; provides regulated DC for ALFAX Printing Channels a for other circuitry in Recording Amplifier.

e. SWITCH OR PENMOTOR AMPLIFIER

One for each channel; receives power from internal Power Supply ar Regulator, operates as on-off switching devices for ALFAX or solen operation or as linear signal amplifiers to operate penmotor record depending on position of ALFAX - SOLENOID - PENMOTOR selecto switch on front panel.

2. SPECIFICATIONS

a. GENERAL FEATURES

Each of the two channels provide the following features:

(1) Alarm relay operation - 6.3 volt normally open and normally closed relay contacts at 3 amperes available to operate externa accessories; and two single-pole, double-throw relay contacts with 5 amperes for external connections.

(2) Signal amplitude output to drive strip-chart recording pens and galvanometers directly. Output is 0 to 60 volts at 1400 ohms impedance.

(3) On-off output for direct drive of facsimile recorders (Alfax typ Output is adjustable from 0 to -60 volts at 200 ohms impedance Maximum current is .30 amps with automatic short-circuit pro tection.

(4) On-off output for external solenoid and relay.

(5) Output for all unamplified Transigate signals.

(6) Independent amplitude and/or on-off outputs.

b. POWER REQUIREMENTS

Power and signal requirements are derived from the UM Reflectoscope through interconnecting cables, plus supplementary internal power supply.

OPERATION

1. FUNCTION OF CONTROLS (Figure 10-1)

a. ALFAX-SOLENOID (pointer)

Sets up each channel of the Recording Amplifier to drive a facsimile recorder (ALFAX) or a low-power solenoid in response to an on-off control signal from the Transigate which is coincident with alarm actuation on the Transigate.

b. PENMOTOR (pointer)

Sets up each channel of the Recording Amplifier to drive a penmotor recorder in response to linear signal from the Transigate which may or may not be coincident with alarm actuation on the Transigate.

c. ALFAX INTENSITY (small outer)

Controls amount of voltage fed to voltage setter circuit in ALFAX Printing Channel and therefore controls amount of drive for ALFAX Recorders and resulting recording intensity.

d. PENMOTOR RANGE (large inner)

Varies amount of resistance in the emitter circuit of the penmotor amplifier and therefore the gain of the amplifier for signals being sent to drive penmotor type recorders.

2. FAMILIARIZATION

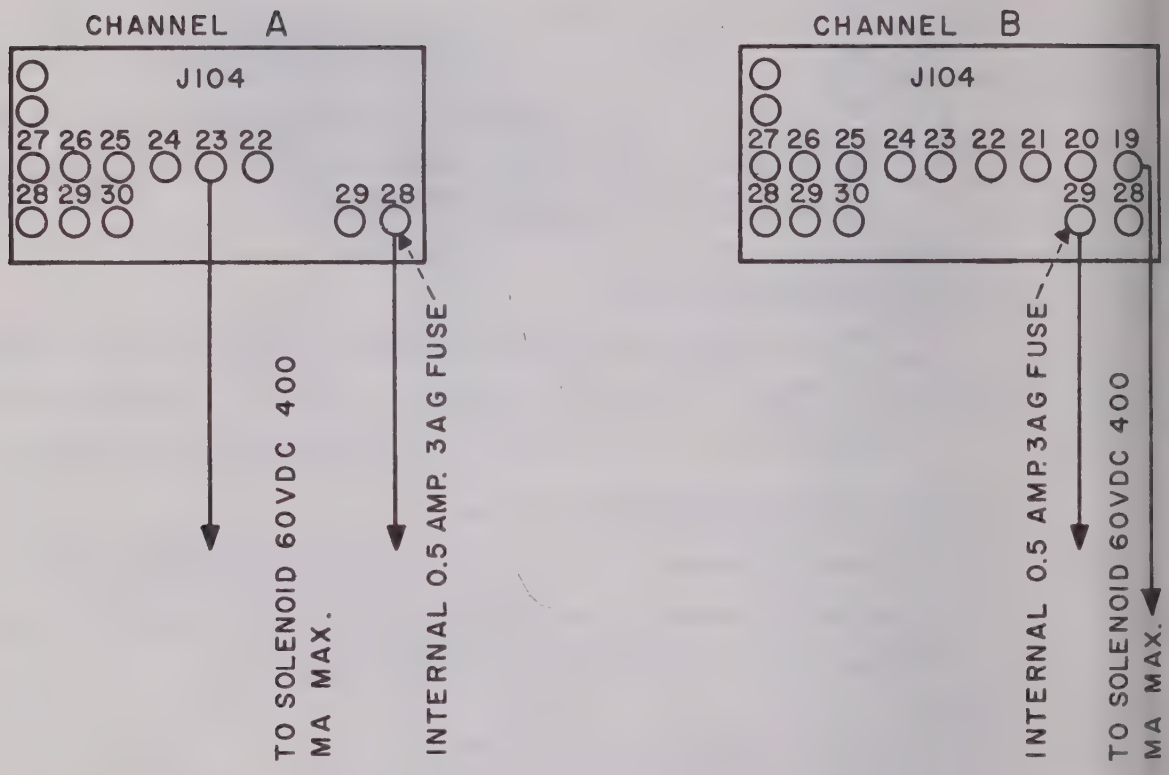
a. SET-UP (Figure 10-1)

Set-up procedure for the Recording Amplifier consists of seeing that it is properly secured in a rear compartment. Automatic mating of connectors interconnects it with the Transigates and UM Reflectoscope. Appropriate connections should be made to external recording or control devices in accordance with information given later in this section.

TO OPERATE SOLENOID FROM TYPE "S" UNIT STYLE 50E530

OUTPUT CONNECTIONS

CONNECTORS VIEWED FROM REAR OF UNIT



1. SET CHANNEL A SWITCH TO ALFAX – SOLENOID POSITION.
2. TO ENERGIZE SOLENOID ON SIGNAL SET TRANSIGATE 50E550 TO + AUTO. TO ENERGIZE SOLENOID ON NO SIGNAL OR SIGNAL DECREASE SET TO – AUTO.
3. VARY PICKOFF POINT WITH LEVEL CONTROL ON TRANSIGATE 50E550.

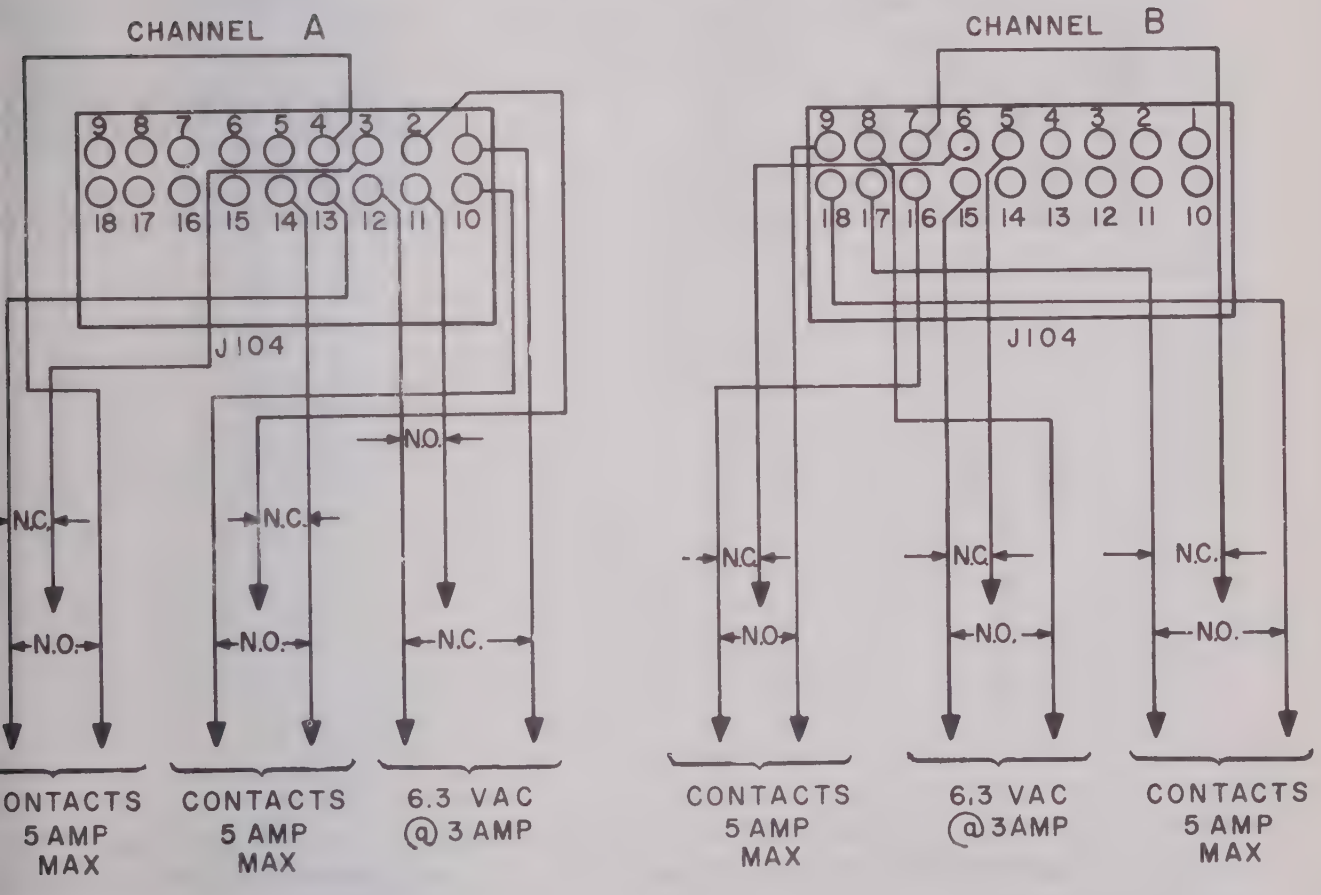
1. SET CHANNEL B SWITCH TO ALFAX SOLENOID POSITION.
2. TO ENERGIZE SOLENOID ON SIG SET TRANSIGATE 50E550 TO + A TO ENERGIZE SOLENOID ON NO S OR SIGNAL DECREASE SET TO
3. VARY PICKOFF POINT WITH LE CONTROL ON TRANSIGATE 50E55

Figure 10-2

TO OPERATE "S" UNIT RELAY OUTPUT
STYLE 50E530

OUTPUT CONNECTIONS

CONNECTIONS VIEWED FROM REAR OF UNIT



1. RELAY WILL CLOSE COINCIDENT WITH CHANNEL A ALARM LIGHT.
2. VARY PICKOFF POINT WITH LEVEL CONTROL ON TRANSIGATE 50E550.

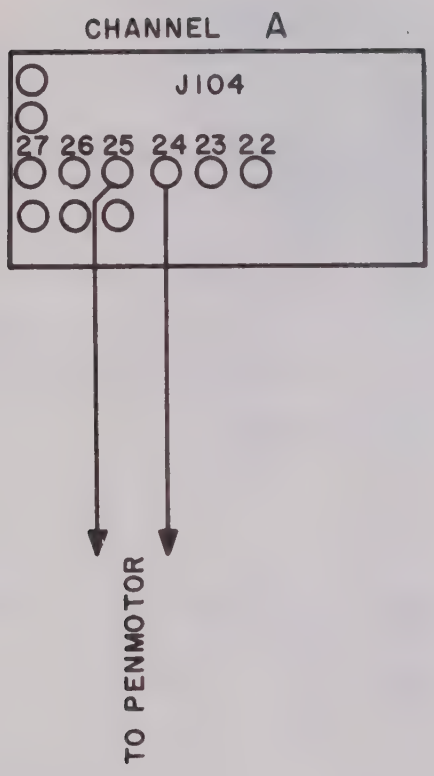
1. RELAY WILL CLOSE COINCIDENT WITH CHANNEL B ALARM LIGHT.
2. VARY PICKOFF POINT WITH LEVEL CONTROL ON TRANSIGATE 50E550.

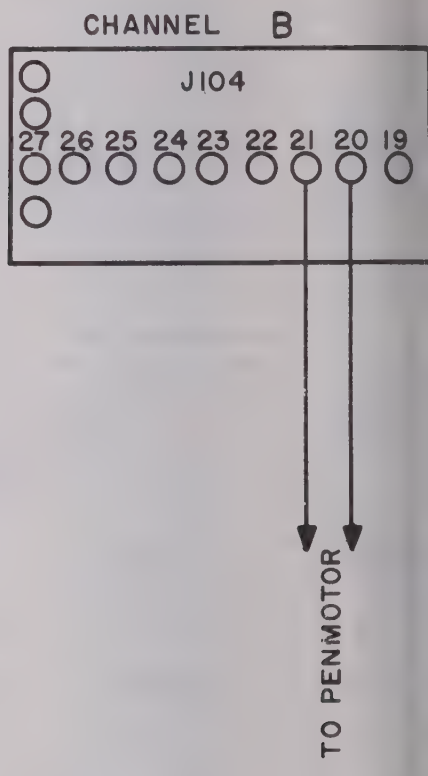
Figure 10-3

TO OPERATE PENMOTOR FROM TYPE "S" UNIT STYLE 50E530

OUTPUT CONNECTIONS

CONNECTORS VIEWED FROM REAR OF UNIT





1. SET CHANNEL A SWITCH TO PENMOTOR POSITION.
2. CONTROL SCALE FACTOR ON PENMOTOR WITH LARGE INNER KNOB ON TYPE "S" UNIT.

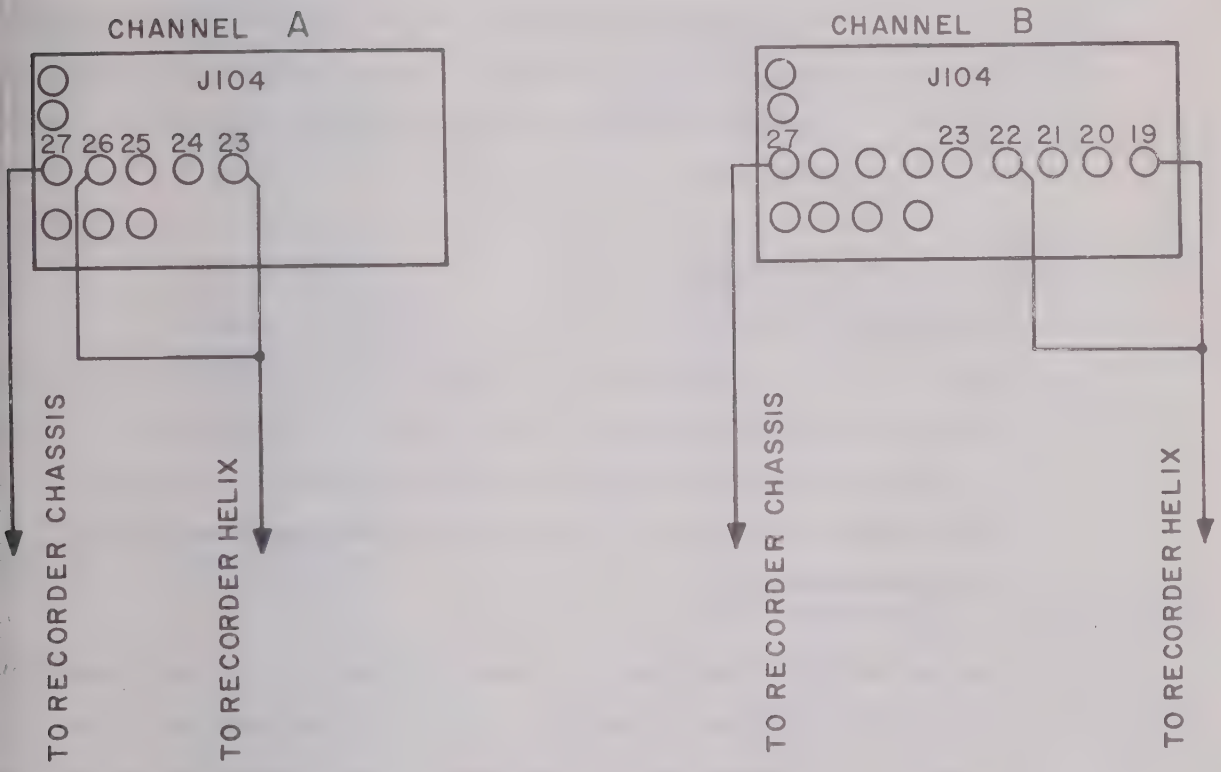
1. SET CHANNEL B SWITCH TO PEN POSITION.
2. CONTROL SCALE FACTOR ON P WITH LARGE INNER KNOB ON TY UNIT.

Figure 10-4

TO OPERATE ALFAX RECORDER FROM TYPE "S" UNIT. STYLE 50E530

OUTPUT CONNECTIONS

CONNECTORS VIEWED FROM REAR OF UNIT



1. SET CHANNEL A SWITCH TO ALFAX–SOLENOID POSITION.
2. VARY PRINT INTENSITY WITH SMALL OUTER KNOB ON TYPE "S" UNIT.
3. RECORDER WILL NOT PRINT WITH TRANSIGATE 50E550 SET TO + AUTO AND SIGNAL IN GATE ABOVE LEVEL.
4. VARY PICKOFF POINT WITH LEVEL CONTROL ON TRANSIGATE 50E550.

1. SET CHANNEL B SWITCH TO ALFAX–SOLENOID POSITION.
2. VARY PRINT INTENSITY WITH SMALL OUTER KNOB ON TYPE "S" UNIT.
3. RECORDER WILL NOT PRINT WITH TRANSIGATE 50E550 SET TO + AUTO AND SIGNAL IN GATE ABOVE LEVEL.
4. VARY PICKOFF POINT WITH LEVEL CONTROL ON TRANSIGATE 50E550.

Figure 10-5

b. FAMILIARIZATION - DETAIL

(1) Connections to appropriate external devices should be made in accordance with the detailed information given in Figures 10-2 through 10-5.

(2) Using information given in the OPERATION section on the Transigate and in Figures 10-2 through 10-5 on the Recording Amplifier, vary controls to achieve the desired operating configuration. Consult handbooks on the external devices before proceding.

PRINCIPLES OF OPERATION

1. GENERAL (Figure 10-6)

Figure 10-6 is a block diagram of the Recording Amplifier. AC power is f to the unit to supply the internal power supply and regulator, and is contro by relay contacts which function as an ON-OFF switch. The relay is closed when the Amplifier is seated in the compartment and the UM Reflectoscope is on.

An internal power supply and regulator supplies -60 volts DC to power the ALFAX Printing Channels and other circuitry in the Amplifier. This is fe to the ALFAX circuits through thermostats which function as overload pro tection for each channel.

The ALFAX Recording Channels provide the print voltage for the ALFAX Recorders and are comprised of a voltage setter circuit and a current limiting and regulating circuit. The ALFAX INT control is an input contro for the voltage setter circuit.

The ALFAX-Solenoid Switches or Penmotor Amplifiers are identical for each channel. Depending upon the position of the ALFAX-SOLENOID PEN- MOTOR switch, the circuits function as on-off switches or voltage amplifiers, respectively. The PENMOTOR RANGE control varies the gain of th voltage amplifier circuit.

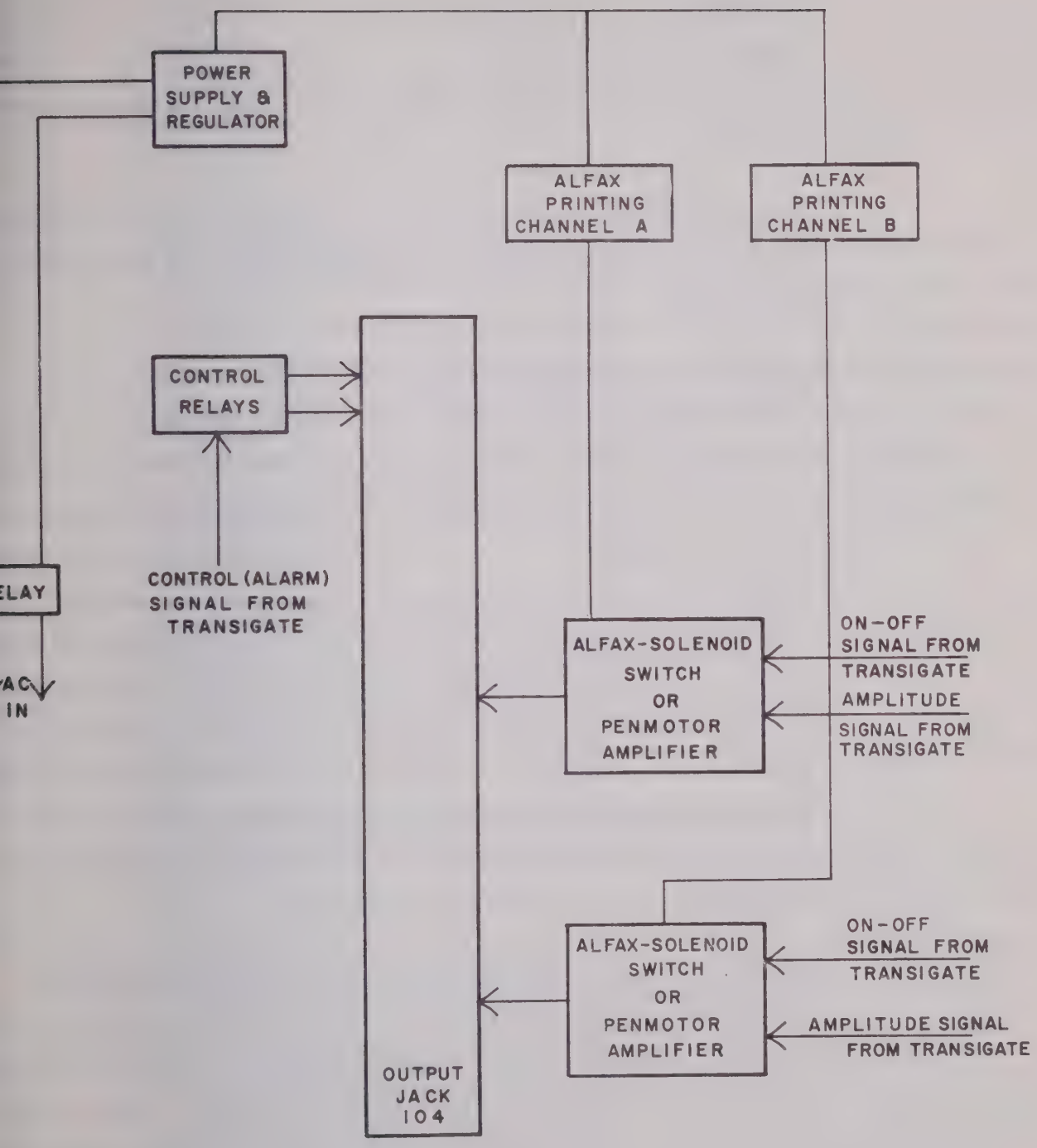


Figure 10-6
Block Diagram of Type S Recording Amplifier

. control relay is also provided for each channel. These receive contro signals from the Transigate which are coincident with alarm actuation o the Transigate. Normally open, normally closed, and 6.3 vac control co tacts are provided on each relay (see figure 10-3). J104 transfers these contacts as well as ALFAX-SOLENOID and PENMOTOR signals to exter devices.

Reference should be made to the overall schematic of the Type S Record Amplifier in the rear of this section during the following detailed discus of circuitry.

2. POWER SUPPLY & REGULATOR

Power transformer T102; CR103, 4, 5, 6; R102 and C103 form the circu for furnishing -64.0 to -90.0 volts DC unregulated to provide recording for both channels. Transistors Q101, Q102 and associated circuitry forn the voltage regulator and driver for recording and control circuits in bot channels. Both fuse and thermostat overload protection is provided. The mostats S103 and 104 are in series with the unregulated supply and regul and are thermally close coupled to the studs of transistors Q104 and Q11 These transistors are mounted on the Type S unit rear plate which is uti as a heat sink. When the combination of power dissipated in Q104 and Q1 ambient rise causes the temperature of the transistors to rise to approx 65°C, the thermostats will open. When the temperature decreases, the t mostats close again, re-energizing the circuit.

3. CHANNEL A OR B OPERATED IN THE ALFAX RECORDING MODE

The operation of Channel A and B is identical. The following discussion to Channel A. Q104 is a series regulator transistor operated in the comm collector mode. Whatever voltage appears at its emitter, which is also t ALFAX recorder output terminal, must also be at its base. Under norma recording conditions the base of Q104 is driven by the emitter of Q103 wh voltage is set by potentiometer R107. At a pre-set voltage and normal re current (under 300 ma) there is very little voltage drop across R141 and therefore CR117 is not connected. However, when the output termina

require more current (because the recorder resistance is lowering) the voltage at the output terminals begins to fall. The voltage drop across R141 and R109 increases, thus connecting CR117. CR117 will then begin to regulate the voltage at the junction of R141, R109 and CR117, shunting the excess current through R113 into the load, or to ground if the output happens to be shorted, or through Q108 (via jumper on pins 23 and 26 of J104) if Q108 is closed (saturated) because of a no-print signal from the Transigate.

The current into the load delivered by Q104 causes a voltage drop across R113. This drop (0 to -.2V) is sensed by Q106 common base amplifier. R110, R112 comprise a voltage divider and load resistance for Q106 and at the same time a biasing network for Q105. This transistor is normally biased off and does not interfere with circuit operation, but when excessive load current is passed through R113 the voltage across it causes Q106 to start into saturation, closing Q105, thus shunting the base of Q104. This tends to keep the output current constant.

The signal for this type of recording is taken from pin 3, J101. Q107 emitter follower passes the signal through R129 and zener diode CR110. CR110, in conjunction with R127, resets the original 0 to -8 volt signal to a +4 to -.3 volt level. This reverse biases the base of Q108 during no signal (print) conditions.

4. CHANNEL A OR B OPERATED AS SOLENOID DRIVER

Operation of the two channels is identical. The following discussion applies to Channel A. Transistor Q108 is operated as a switch that is driven from Q107. If the solenoid is connected between pin 28, J104 and pin 23, J104 the solenoid will activate if pin 3, J101 is at -8 vdc and will turn off if pin 3 is 0 volts. The -8 vdc signal is transferred through Q107 emitter follower and is reset to a new level via CR110, R129 and R127 (S101 in ALFAX-SOLENOID position). When the input at pin 3, J101 is 0 volts the base of Q108 is +4 volts. When the input is -8 volts the base of Q108 is approximately -.3 volts. This drives Q108 into saturation, causing it to act as a switch which makes the solenoid work. CR109 diode is used to quench the large negative transient that would ordinarily occur when Q108 is turned off.

5. CHANNEL A OR B OPERATED AS PENMOTOR AMPLIFIER

Operation of the two channels is identical. The following discussion applies Channel A. When S101 is in PENMOTOR position, Q108 and Q107 are conne as a direct coupled amplifier. The input signal is now taken from pin 21, J1 and is passed via CR111 through Q107 emitter follower. R128 provides sign current limiting in the base of Q108. R143 helps to provide a constant impe for input to Q108 to keep this transistor temperature stable. C105 provides high frequency degeneration in the final stage to limit the band width of the amplifier and to eliminate the possibility of H.F. oscillations. R123 acts as the load resistance for Q108. R121, R122 resistive divider set about -30 vd at one side of the penmotor coils. This is done to set the electrical center scale voltage to approximately penmotor mechanical center. The resistance R121, R122, R123 and Q108 output impedance combine to critically damp th penmotor.

6. RELAY OUTPUT

Pins 10 through 14 and 1 through 4, J104 are utilized for operating external devices in Channel A. One of three sets of contacts (pins 1, 11, 12, J104) a connected to 6.3 vac, 60 cycles, at 3 amperes (secondary of T101). T101 primary is energized through relay K103 contacts and remains so as long a the line switch located on the UM Reflectoscope is turned on and the proper jumper cables are connected between the S unit and the UM. Pins 8 and 13, J101 (Channel A) furnish a half wave, 6.3V signal into C102 through CR102. This becomes a smoothed DC level that energizes the coil of K102. The dur of this signal is coincident with the alarm light on the Transigate.

Except for pin and connector numbers, the circuitry associated with K101 (Channel B) is identical to that of K102 (Channel A).

TYPE S RECORDING AMPLIFIER

CONTROL	SETTING
Alfax Solenoid-Penmotor Switch	Alfax-Solenoid and Penmotor
ALFAX INT	Mid Range
Penmotor Range	Mid Range

Type S Recording Amplifier inoperative or operation is irregular in all modes.

Check that unit is properly in place, UM Reflectoscope and Transigate are operating properly, cables are connected and firmly seated, controls on Recording Amplifier are properly set.

Remove Recording Amplifier and visually inspect for loose or missing components, or connections on wires or components, burned components, or other obvious trouble.

Check for proper supply voltage in unit and check fuses.

arm Relay
esn't operate

ck voltage from
& J102 pin 17
- 2.5 volts DC

heck relay

No Penmotor operation

Check voltage from pin 21 J101 & J102 to ground. Varies with signal from +12 to 0 volts.

Check appropriate channel penmotor output voltage on J104. Varies with signal -25 to +30 volts

Check channel A or B circuits & transistors

No Alfax-Solenoid operation

Check voltage from pin 3 J101 & J102 to ground 0 volts on -8 volts off

Check J104 output voltage level - is adjustable from 0 to 60V with INT control

Check Channel A or B voltage setter circuits & transistors

Same for switch ckt

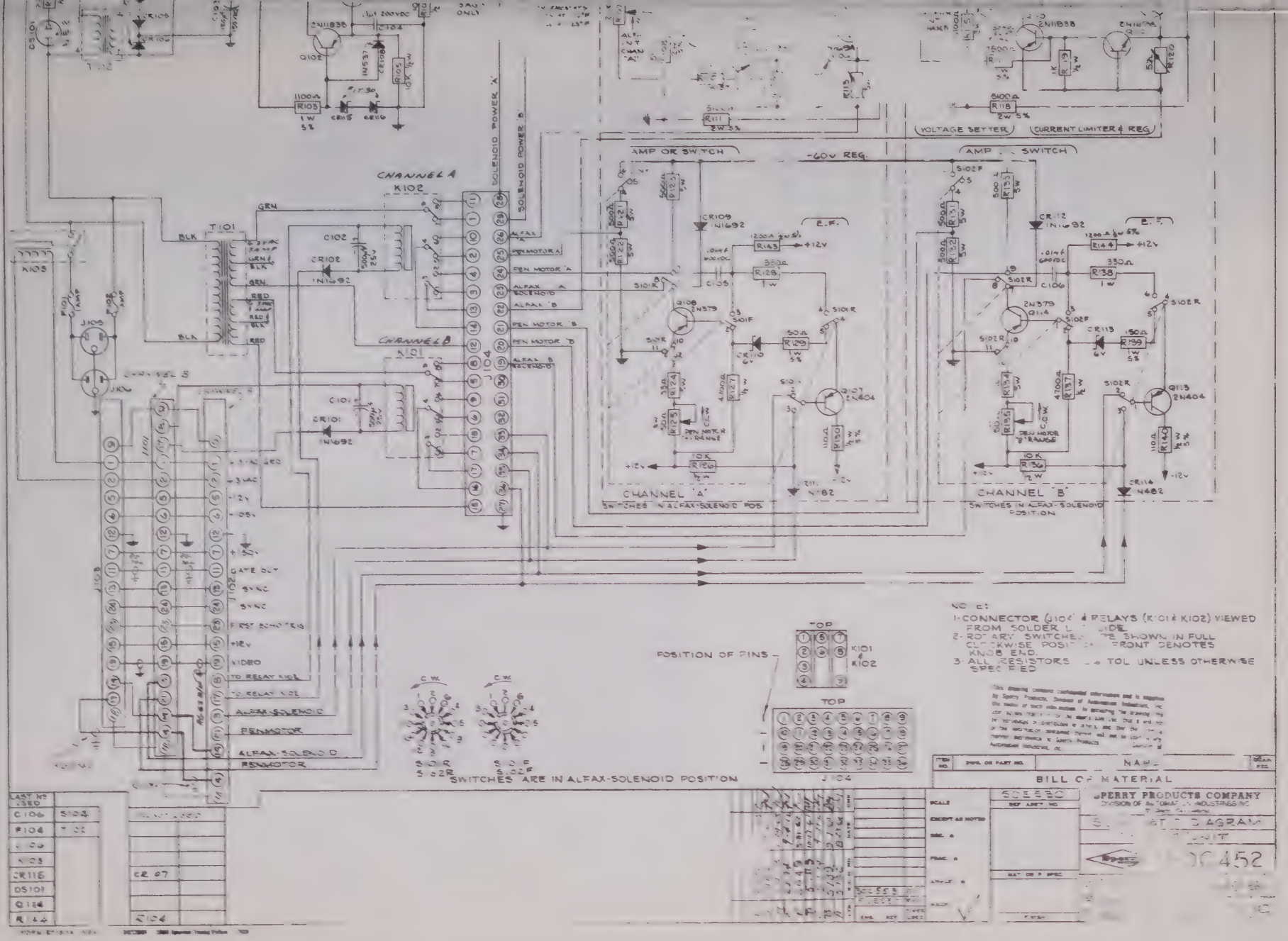
PARTS LIST

TYPE S RECORDING AMPLIFIER - STYLE 50E530

Reference Schematic 50C452

Schematic Symbol No.	Sperry Part No.	Description
C101	DQL001A23	Capacitor 500 uf 25 vdc
C102	DQL001A23	Capacitor 500 uf 25 vdc
C103	Sprague	Capacitor 120 uf 150 vdc TVL1425
C104	DQG001A05	Capacitor .1 uf 200 vdc
C105	DQJ006A13	Capacitor .01 uf 600 vdc
C106	DQJ006A13	Capacitor .01 uf 600 vdc
CR101	IN1692	Diode
CR102	IN1692	Diode
CR103	IN2848	Diode
CR104	IN2848	Diode
CR105	IN2848	Diode
CR106	IN2848	Diode
CR107	Not Used	
CR108	IN537	Diode
CR109	IN1692	Diode
CR110	Hoffman RS-6	Zener Diode
CR111	IN482	Diode
CR112	IN1692	Diode
CR113	Hoffman RS-6	Zener Diode
CR114	IN482	Diode
CR115	Sarkes-Tarzian	Zener Diode IT30
CR116	Sarkes-Tarzian	Zener Diode IT30
CR117	IN482	Diode
CR118	IN482	Diode
R101	DPA005E05	Resistor 220K 1/2W
R102	DPB001A06	Resistor 5 ohms 10W Wire Wound
R103	DPA006C02	Resistor 1100 ohms 1W 5%
R104	Not Used	
R105	DPA005D01	Resistor 10K 1/2W 10%
R106	DPA005D01	Resistor 10K 1/2W 10%
R107		Potentiometer 25K 2W
R108	DPA008C18	Resistor 5100 ohms 2W 5%
R109	DPA004B03	Resistor 120 ohms 1/2W 5%
R110	DPA006C22	Resistor 7500 ohms 1W 5%
R111	DPA008C18	Resistor 5100 ohms 2W 5%
R112	DPA005C01	Resistor 1K 1/2W 10%
R113	Continental Wirt	Rheostat 5 ohms WC808A
R114		Potentiometer 25K 2W
R115	DPA008C18	Resistor 5100 ohms 2W 5%
R116	DPA004B03	Resistor 120 ohms 1/2W 5%
R117	DPA006C22	Resistor 7500 ohms 1W 5%
R118	DPA008C18	Resistor 5100 ohms 2W 5%
R119	DPA005C01	Resistor 1K 1/2W 10%
R120	Continental Wirt	Rheostat 5 ohms WC808A
R121	CNA002A28	Resistor 500 ohms 5W 10%
R122	CNA002A28	Resistor 500 ohms 5W 10%
R123	CNA002A28	Resistor 500 ohms 5W 10%
R124	CNA002A14	Resistor 35 ohms 5W 10%
R125	50A2638	Variable Resistor 50 ohms 3W
R126		Resistor 10K 1/2W 10%
R127	DPA005C09	Resistor 4700 ohms 1/2W 10%
R128	DPA007B07	Resistor 330 ohms 1W 10%
R129	DPA006B05	Resistor 150 ohms 1W 5%
R130	DPA004B02	Resistor 110 ohms 1/2W 5%
R131	CNA002A28	Resistor 500 ohms 5W 10%
R132	CNA002A28	Resistor 500 ohms 5W 10%
R133	CNA002A28	Resistor 500 ohms 5W 10%
R134	CNA002A14	Resistor 35 ohms 5W 10%
R135	50A2638	Variable Resistor 50 ohms 3W
R136	DPA005D01	Resistor 10K 1/2W 10%

Schematic Symbol No.	Sperry Part No.	Description
R137	DPA005C09	Resistor 4700 ohms 1/2W 10%
R138	DPA007B07	Resistor 330 ohms 1W 10%
R139	DPA006B05	Resistor 150 ohms 1W 5%
R140	DPA004B02	Resistor 110 ohms 1/2W 5%
R141	CNA002A32	Resistor 800 ohms 5W 5%
R142	CNA002A32	Resistor 800 ohms 5W 5%
R143	DPA004C03	Resistor 1200 ohms 1/2W 5%
R144	DPA004C03	Resistor 1200 ohms 1/2W 5%
T101	Triad	Transformer F-32A
T102	Microtran Co.	Transformer M8024
K101	Potter-Brumfield	Relay with stud Series KA
K102	Potter-Brumfield	Relay with stud Series KA
K103	Sigma	Relay 41F210ACG
Q101	2N174	Transistor with Mfg. Kit
Q102	2N1183B	Transistor
Q103	2N1183B	Transistor
Q104	2N174	Transistor with Mfg. Kit
Q105	2N1183B	Transistor
Q106	2N169A	Transistor
Q107	2N404	Transistor
Q108	2N379	Transistor
Q109	2N1183B	Transistor
Q110	2N1183B	Transistor
Q111	2N174	Transistor with Mfg. Kit
Q112	2N169A	Transistor
Q113	2N404	Transistor
Q114	2N379	Transistor
F101	CJA004C06	Fuse 1 ampere
F102	CJA004C06	Fuse 1 ampere
F103	CJA004C04	Fuse 1/2 ampere 3AG
F104	CJA004C04	Fuse 1/2 ampere 3AG
DS101	NE2	Lamp, Neon
S101	50A2637	Switch, Rotary
S102	50A2637	Switch, Rotary
S103	Part of Thermostat	
S104	Part of Thermostat	
J101	CQC017S01	Connector
J102	CQC017S01	Connector
J103	Amphenol	Connector 26-4401-24P
J104	Elco	Connector RF23620-5
J105	Hubbell	Receptacle 5258
J106	Tektronix	Plug 131-108
	Ulanet	Thermostat 12S open 143°F ±5% Close 123°F ±5%
	CJA008A02	Fuse Block
	CJA003A01	Fuse Extractor Post
	AN3195-3	Fastener-Snapslide
	Pem	Captive Stud FH-440-5
	RG62B/U	Coaxial Cable
	Raytheon	Knob 50-4-1G Red
	Raytheon	Knob 70-1-CB-2G 1/4 Dia. Shaft
	Raytheon	Knob 50-1-1G Control
	00A078	Nameplate
	Bendix	Transistor Socket 210-6500


CHANNEL A
K102
CHANNEL B
K101
SOLENOID POWER 'A'
SOLENOID POWER 'B'
J104
T101
J103
J102
J101
ALFAX
PEN MOTOR A
PEN MOTOR 'A'
ALFAX 'A' SOLENOID
ALFAX 'B'
PEN MOTOR 'B'
ALFAX 'B' SOLENOID
GRN
BLK
RED
WHT
+ 1 VAC REG
+ 3 VAC
+ 12 V
- 105 V
+ 150 V
GATE OUT
SYNC
SYNC
FIRST SWEEP
+12V
VIDEO
TO RELAY K101
TO RELAY K102
ALFAX SOLENOID
PEN MOTOR
ALFAX SOLENOID
PEN MOTOR
Q102 2N1838
Q103 2N1838
Q104 2N1838
Q105 2N1838
Q108 2N379
Q107 2N404
Q114 2N379
Q113 2N404
CR109 IN1692
CR110 IN1692
CR111 IN1692
CR112 IN1692
CR113 6V
CR114 IN482
CR102 IN1692
CR101 IN1692
CR103 IN5372
CR104 6E16
CR105 6E16
CR106 6E16
CR107 6E16
CR108 6E16
VOLTAGE SETTER
CURRENT LIMITER & REG
-60V REG.
AMP OR SW.TCH
AMP SWITCH
CHANNEL 'A'
SWITCHES IN ALFAX-SOLENOID POS
CHANNEL 'B'
SWITCHES IN ALFAX-SOLENOID POSITION
S101R
S101F
S102R
S102F
S101 R
S101 F
S102 R
S102 F
S01R
S01F
S02R
S02F
SWITCHES ARE IN ALFAX-SOLENOID POSITION
POSITION OF PINS
TOP
K101
K102
J104
NOTES:
1-CONNECTOR (J104) & RELAYS (K101 & K102) VIEWED FROM SOLDER LUG SIDE.
2-ROTARY SWITCHES SHOWN IN FULL CLOCKWISE POSITION. FRONT DENOTES KNOB END.
3-ALL RESISTORS ± 5% TOL UNLESS OTHERWISE SPECIFIED
BILL OF MATERIAL
PERRY PRODUCTS COMPANY
DIVISION OF AMERICAN INDUSTRIES INC
SCALE
EXCEPT AS NOTED
DECIMALS
FRACTIONS
ANGLES
MATERIAL
FINISH
DO NOT SCALE DRAWING
SOLENOID DRIVER
SCHEMATIC DIAGRAM
CIRCUIT
DC 452
LAST NO USED
C106
R104
K102
K103
CR116
DS101
Q114
R144
S102
CR 67
K104

SECTION XI

TYPE R RELAY CHASSIS

DESCRIPTION

1. GENERAL

The Type R Relay Chassis incorporates two separate channels which enables it to accept information from one or two Transigates. Each channel provides signals for operation of external recorders, solenoids, alarms and controls through external amplifiers. The unit is designed to fit into either of two rear compartments in the Special Function Cabinet. When it is firmly seated in the cabinet it makes automatic contact with the Transigates (mounted in the front compartments of the Special Function Cabinet) through mating connectors. The Relay Chassis consists of the following major components:

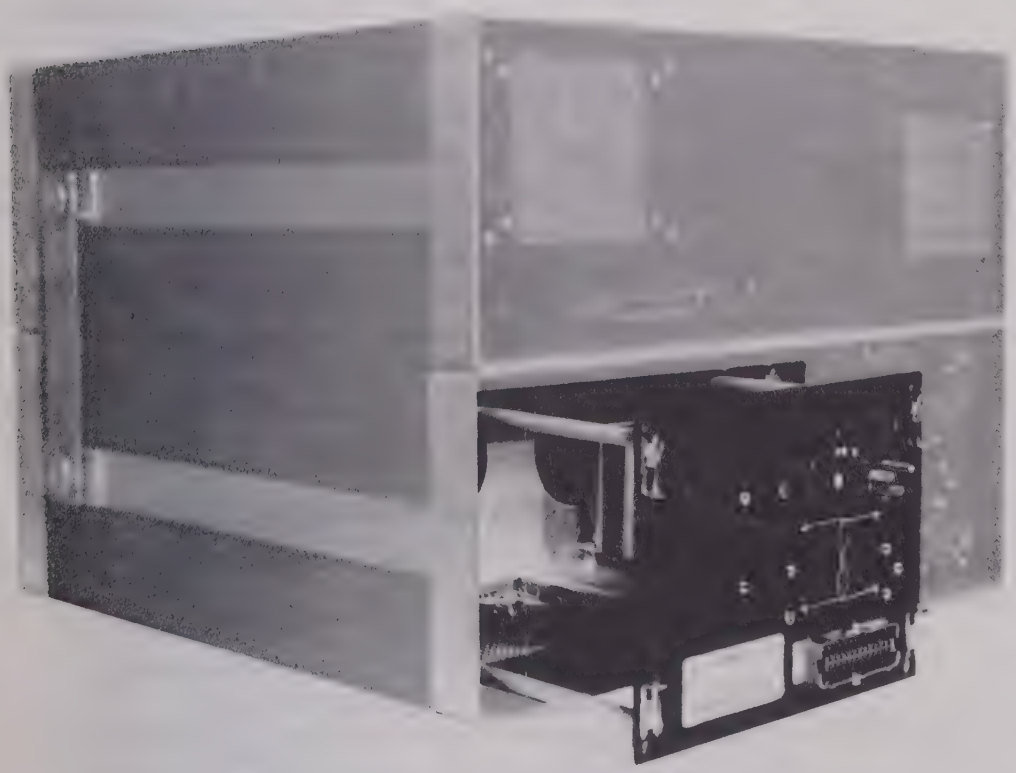


Figure 11-1
Type R Relay Chassis

a. POWER ON-OFF RELAY

Functions as power ON-OFF switch for Relay Chassis, feeding pow to control relay transformer as long as Relay Chassis is seated an UM Reflectoscope is on.

b. TRANSFORMER

Provides 6.3 volts AC at output contacts of control relays.

c. CONTROL RELAYS

Receive signal coincident with alarm actuation on Transigate, prov control contacts at output of Relay Chassis.

d. OUTPUT CONNECTOR

Transfers contacts of control relays to external devices. Also mak available Transigate ALFAX and PENMOTOR signals for external amplifiers and drivers.

2. SPECIFICATIONS

a. GENERAL FEATURES

Each of the two output channels provides:

(1) 6.3 volt normally open and normally closed relay contacts at 3 amperes maximum (internal).

(2) Two single-pole, double-throw relay contacts for external connections through 5 ampere contacts.

(3) Signal output to drive a strip-chart recorder or ALFAX recorder with external amplifier.

b. PENMOTOR SIGNAL OUTPUT CHARACTERISTICS

(1)	Voltage range	+12 to 0 v
(2)	Output impedance	1000 ohms

c. ALFAX SIGNAL OUTPUT CHARACTERISTICS

(1)	Voltage range	0 to -8 v
(2)	Output impedance	500 ohms

d. POWER REQUIREMENTS

Power and signal requirements for the Relay Chassis are derived f the UM Reflectoscope through interconnecting power and signal jun cables.

OPERATION

1. FAMILIARIZATION

a. SET-UP

Set-up procedure for the Relay Chassis consists of seeing that it is properly installed and seated in a rear compartment. Automatic mating of connectors interconnects it with the Transigates and the UM Reflectoscope. Appropriate connections should be made to external amplifiers and control devices in accordance with information given later in this section.

b. FAMILIARIZATION - DETAIL

(1) Connections to appropriate external devices should be made in accordance with the detailed information given in Figure 11-2.

(2) Using information given in the OPERATION section on the Transigate, vary controls to achieve the desired operating configuration. Consult handbooks on the external devices before proceding.

PRINCIPLES OF OPERATION

1. GENERAL (Figure 11-3)

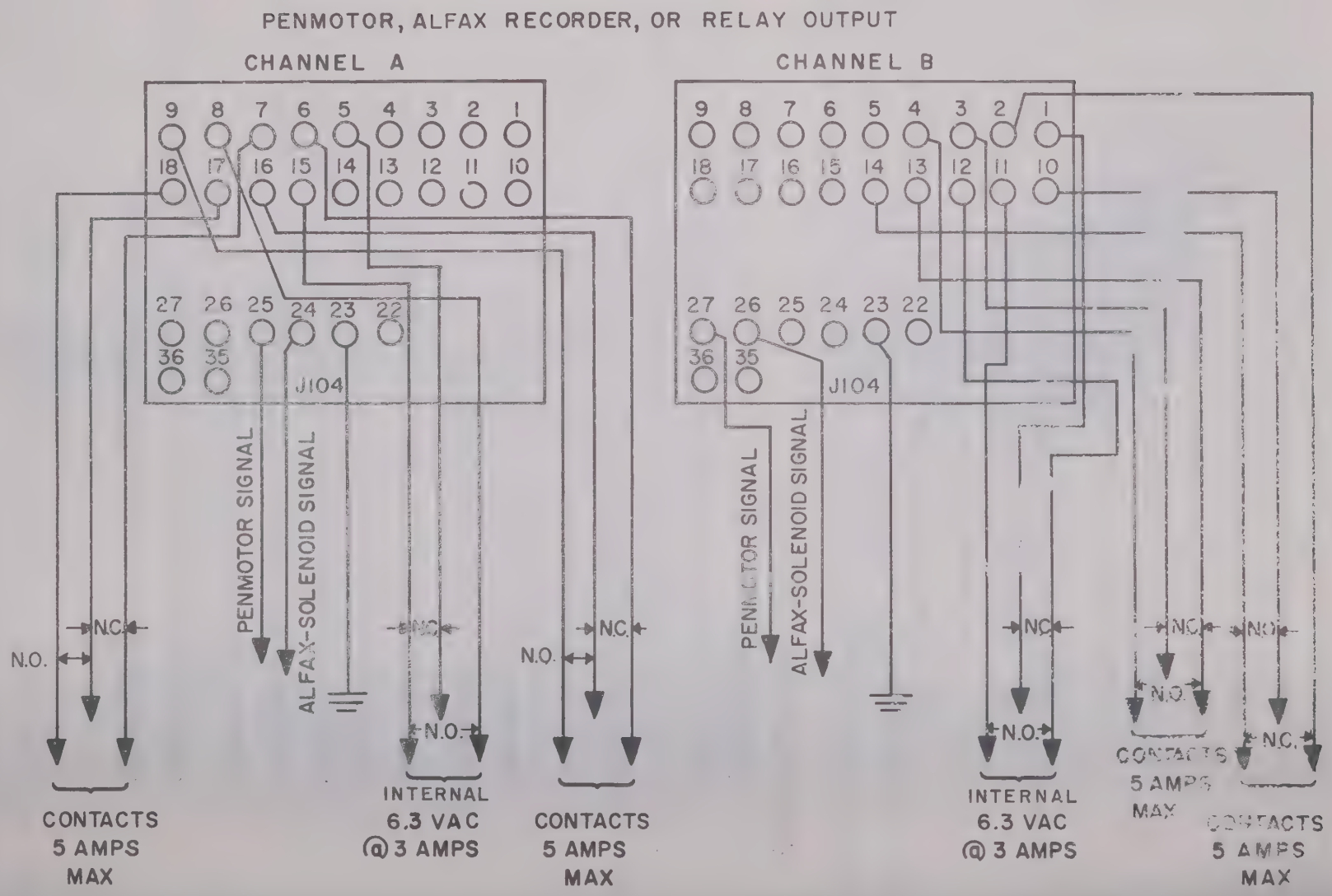
Figure 11-3 is a block diagram of the Type R Relay Chassis. AC power is fed to the unit to supply the control relay transformer, and is controlled by relay contacts which function as an ON-OFF switch. The relay is closed as long as the Relay Chassis is seated and the UM Reflectoscope is turned on.

The transformer secondary supplies 6.3 vac at 3 amperes maximum to one set of contacts on the control relay.

The control relays receive signals from the Transigate which are coincident with alarm actuation on the Transigate. Control contacts on the relays are transferred to external devices through the output connector J104. The output connector also transfers ALFAX and PENMOTOR signals from the Transigate to external amplifiers and drivers.

Reference should be made to the overall schematic of the Relay Chassis in the rear of this section during the following discussion.

TO OPERATE TYPE R RELAY CHASSIS STYLE 50C434



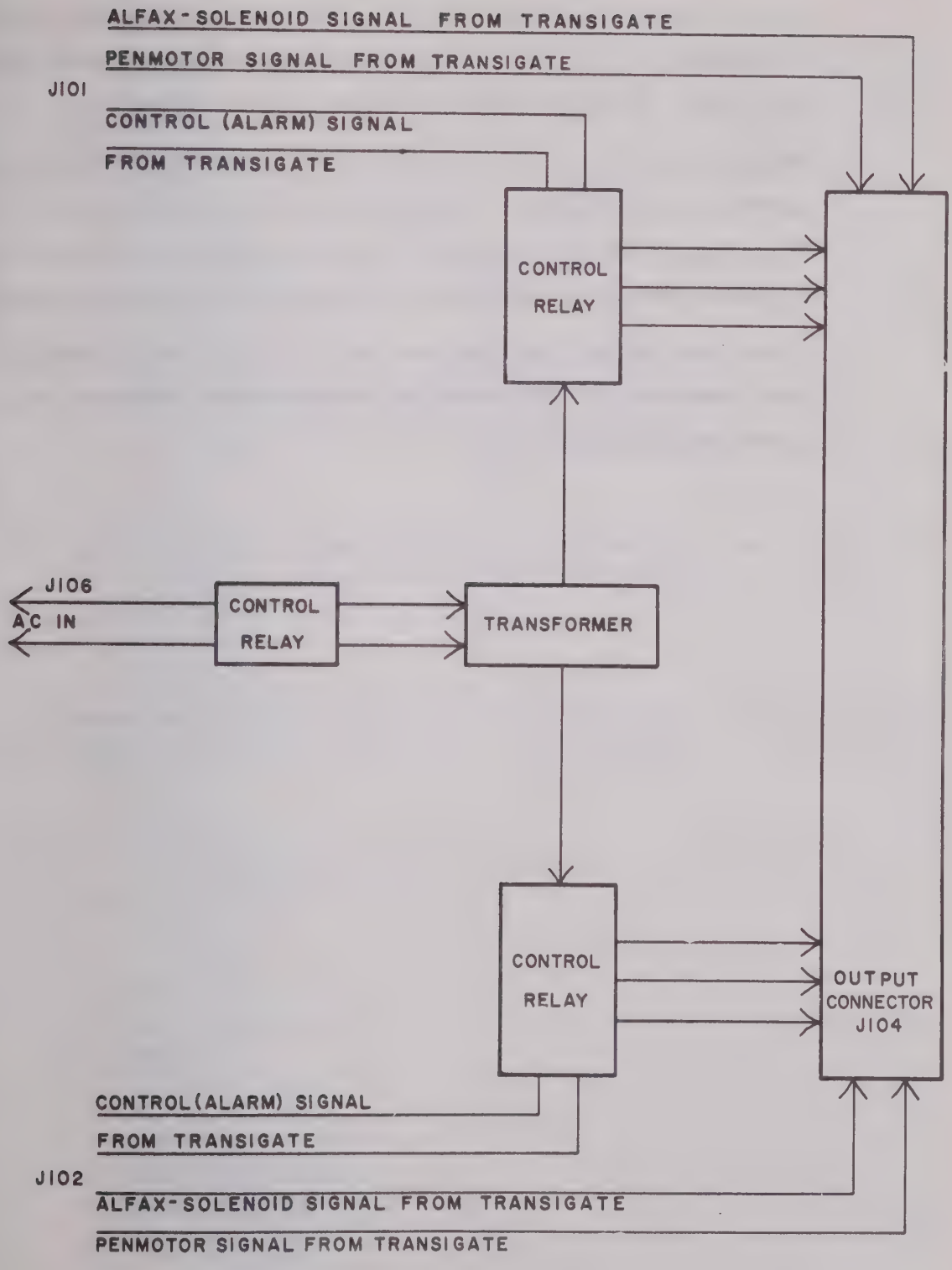


Figure 11-3
Block Diagram of Type R Relay Chassis

2. CIRCUIT OPERATION

When properly connected to the UM Reflectoscope and Special Function Cabine power is brought in through J106 and, provided relay K103 is actuated, is fed to transformer T101. Two secondary windings provide 6.3 vac at 3 amperes maximum to one set of contacts on control relays K101 and K102.

Relays K101 and K102 receive signals from the Transigate coincident with ala actuation on the Transigate through pins 8 and 17 on J101 and J102, respectiv These signals are fed to C101 and C102 through diodes CR101 and CR102. Thi provides a smoothing action when the coils of the relays are energized.

ALFAX and PENMOTOR signals are brought in to the Relay Chassis on pins 3 and 2, respectively, of J101 and 102 and transferred to external devices thro pins on output connector J104.

TYPE R RELAY CHASSIS

Control Settings

None

Relay Chassis inoperative or irregular, no ALFAX or PENMOTOR signal and no control relay action.

Check that unit is properly in place. UM Reflectoscope and Transigate are operating properly, cables are connected and firmly seated.

Remove Relay Chassis and visually inspect for loose or missing components, poor connections on wires or components, burned components, or other obvious trouble.

Check for proper supply voltage in unit and check fuses.

No 6.3 vac control voltage

Check relay circuit and relay contacts

No 5 ampere contact operation

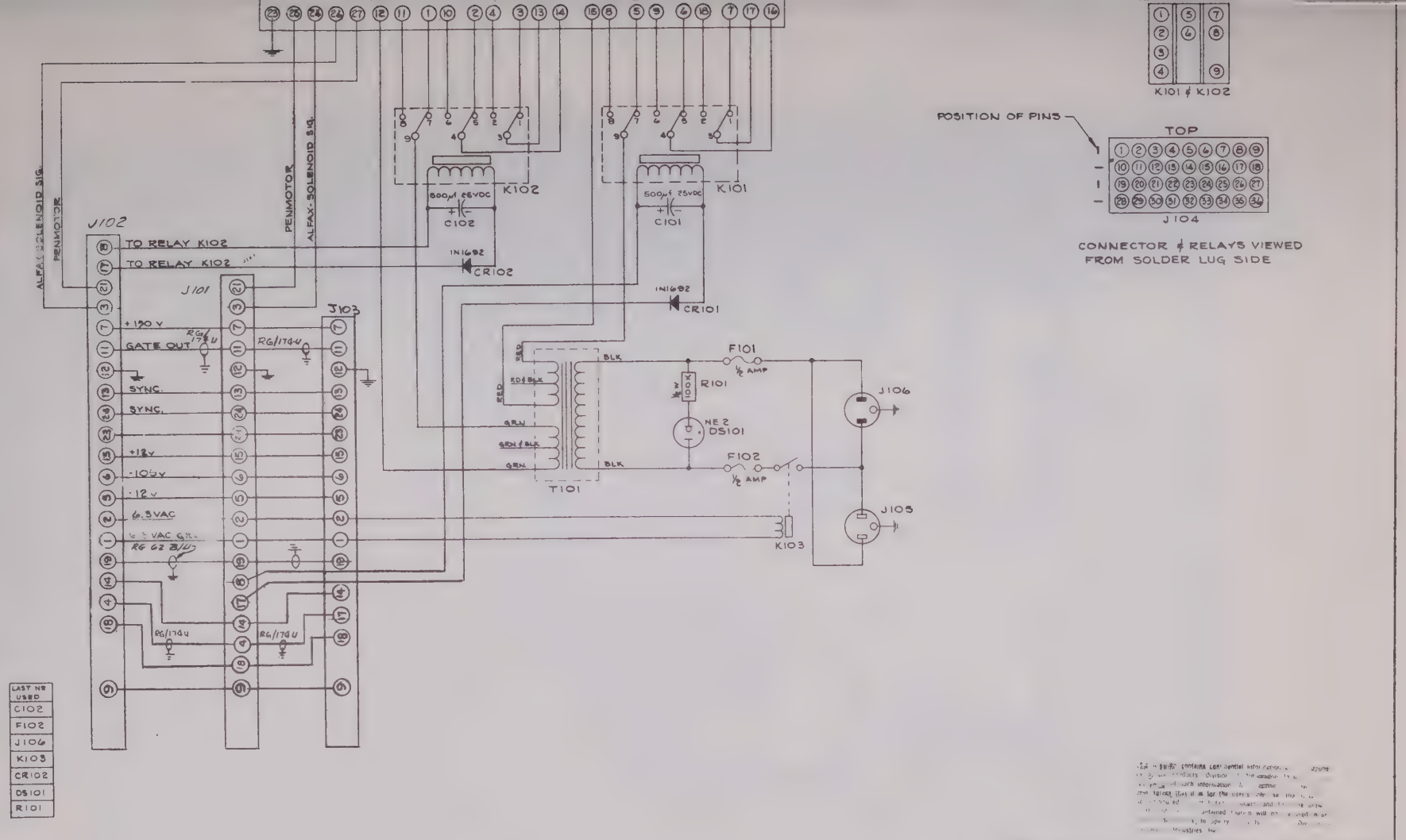
Check relay circuit and relay contacts

PARTS LIST

TYPE R RELAY CHASSIS - STYLE 50C434

Reference Schematic 50C438

Schematic Symbol No.	Sperry Part No.	Description
C101	DQL001A23	Capacitor 500 uf 25 vdc
C102	DQL001A23	Capacitor 500 uf 25 vdc
CR101	IN1692	Diode
CR102	IN1692	Diode
R101	DPA005E01	Resistor 100K 1/2W
T101	F-32A	Transformer - Triad
K101	Potter-Brumfield	Relay w/stud #6-32-6vdc-3PDT Series KA
K102	Potter-Brumfield	Relay w/stud #6-32-6vdc-3PDT Series KA
K103	41F210ACG-SIL	Relay-Sigma
F101	CJA004C04	Fuse 1/2 ampere
F102	CJA004C04	Fuse 1/2 ampere
DS101	NE-2	Lamp - Neon
J101	CQC017S01	Connector
J102	CQC017S01	Connector
J103	Amphenol	Connector - 26-4401-24P
J104	Elco	Connector - RF23620-5
J105	Hubbell	Receptacle - 5258
J106	Tektronix	Plug - 131-108
	CJA003A01	Fuse Extractor Post
	RG-62B/U	Coaxial Cable
	AN3195-3	Fastener - Snapslide
	00A078	Nameplate



CONNECTOR & RELAYS VIEWED FROM SOLDER LUG SIDE

LAST NO USED
C102
F102
J106
K103
CR102
DS101
R101

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ITEM NO	DWG. OR PART NO	NAME	QUAN. REQ.

BILL OF MATERIAL

LTR	ECN NO	DATE	CHK
E	6041	11-11-63	
D	6464	12-2-63	
C	6721	1-28-64	
B	6370	1-4-63	
A	6233	9-4-62	

ENG.	REF.	TIMES USED
50C558	REF	
50C434	REF	

SCALE
EXCEPT AS NOTED
DEC. ±
FRAC. ±
ANGLES ±
MACH. ✓
MAT. OR A. SPEC.
FINISH

50C434
REF. ASS'Y NO

SPERRY PRODUCTS COMPANY
DIVISION OF AUTOMATION INDUSTRIES INC
Danbury, Connecticut

SCHEMATIC DIAGRAM
RELAY CHASSIS

SPERRY 50C438

DRAWN BY: E MARQUIS 12 6 61
CHECKED BY: MUNGER 2-8
APPROVED BY: MUNGER 2-8
MFG. CHECK BY
DATE

50C438

FORM E318.1A (11/59)

Figure 1

TRANSIGRAPH - STYLE 50E543

SECTION XII

TRANSIGRAPH - STYLE 50E543

DESCRIPTION

1. GENERAL

The Transigraph has been designed to plug into the Special Function Cabinet for operation with Type UM Reflectoscopes. The Transigraph is used in conjunction with a standard or fast Transigate, an STF Recording Amplifier and a UM Reflectoscope.

The Transigraph, in conjunction with the Type STF Recording Chassis, Transigate and Recorder, will print a plan view of the test piece showing defect location and relative size or changes in material density, indicated by darker or lighter printing. This is accomplished by having the recorder signal vary directly with the gated signal amplitude.

a. The Transigraph incorporates an input board and an amplifier board. A front panel meter is provided, which serves two purposes:

   (1) With SETUP-OPERATE switch in SETUP position, the meter will directly read the calibrated input in inches. This permits easy setting of printing start and stop levels.

   (2) With SETUP-OPERATE switch in OPERATE position, the meter directly reads the CRT signal level in inches.

b. A plus or minus switch provides "white-on-black" or "black-on-white" recording respectively.

c. The Transigraph consists of the following major components:

   (1) Input P.C. Board 50C751 - printed circuit board contains circuitry for accurate DC amplification and positioning of lower and upper levels regardless of output switch position.

   (2) Amplifier board 50C752 - printed circuit board contains circuitry for accepting output of Transigate and amplifying it to obtain a reading on the meter. It also provides the final amplifier output to STF chassis.

   (3) Front and rear panel assembly - structural portion of Transigraph which accepts individual circuit boards; containing meter and external controls on front panel and connectors for interconnecting Transigraph.

2. MECHANICAL SPECIFICATIONS

The following components and controls are mounted on the front panel (see Figure 1).

a. CALIBRATED INPUT (knob)

b. SETUP - OPERATE (switch)

c. SIGNAL LEVEL (meter)

d. UPPER LIMIT ADJ. (knob)

e. LOWER LIMIT ADJ. (knob)

f. INTENSITY (knob)

g. PLUS OR MINUS OUTPUT (switch)

3. ELECTRICAL SPECIFICATIONS

All power requirements are obtained from the UM Reflectoscope Display Unit.

4. PERFORMANCE SPECIFICATIONS

a. To operate strip-chart recorders on any signal appearing in the gated area, a DC recording signal (0 to 60V) is provided that is proportional to the signal amplitude between the upper and lower limits and the position of the intensity control. This signal has instantaneous response. Duration is equal to the time the signal remains in gate at an amplitude between upper and lower level set points.

b. With input in plus position, printing will start from darkest at lower limit and will decrease to lightest at upper limit. With input in minus position, reverse will occur.

c. Level at which recording starts is adjustable from 5% to 95% of full scale (on CRT) signal.

d. Signal change required to go from lightest to darkest recording. Is adjustable from 5% to 75%.

e. Stable and reliable operation is provided over the range of 0°F to 120°F.

OPERATING INSTRUCTIONS

1. FUNCTION OF CONTROLS (Figure 1)

a. CALIBRATED INPUT (knob)
To set up a simulated input on meter when OPERATE-SETUP switch is in setup position.

b. LIMIT ADJUSTS (knob)
To set upper and lower levels of printing.

c. INTENSITY (Vernier)
To set the shade of darkness.

d. OUTPUT (switch)
Plus or minus position determines if printing will be plus white on black or minus black on white.

e. SETUP-OPERATE SWITCH
Permits two modes of operation:

(1) Setup position uses calibrated input.

(2) Operate position uses signal amplitude from Reflectoscope.

2. SETUP - GENERAL

a. FRONT CONNECTIONS
When facing the instrument, the Transigraph plugs into the right side and the Transigate plugs into the left side of the STF recording amplifier.

b. REAR CONNECTIONS
AC power from Reflectoscope to STF recording amplifier. Interconnecting control cable (50B840C) from Reflectoscope to J103 on STF recording amplifier. Recorder output is available at J104 from pin #26 to chassis ground (pin 27).

3. SETUP - DETAIL (Using actual signals from UM Pulser/Receiver)

a. Set the PLUS-MINUS switch in the plus position.

b. Set the SETUP-OPERATE switch to OPERATE; turn the INTENSITY control fully clockwise, turn both UPPER and LOWER LIMIT ADJ. fully CCW and connect a voltmeter across the Alfax recorder terminals (J104 pin #26 and ground).

c. Obtain a signal level within the gate of the UM Reflectoscope using a standard test block and, by means of the UM sensitivity control, set this signal amplitude to that level at which Alfax printing is to start.

d. Adjust the LOWER LEVEL control until the voltmeter pointer just begins to move from its saturated position.

e. By means of the UM sensitivity control, adjust the signal amplitude to that level at which Alfax printing is to indicate full scale (saturation

f. Adjust the UPPER LEVEL control until the voltmeter pointer just reaches its minimum reading.

g. The levels at which Alfax printing will start and stop have now been set. These levels may be checked by varying the UM signal from zero to full scale. The meter will begin to move from a maximum when the LOWER LEVEL is reached and will go to a minimum when the UPPER LEVEL is reached.

h. Additional voltage range (or recorder writing intensity) may be obtained by rotating LOWER LEVEL control in d. beyond the "just begins to move" point. Excessive rotation at this point will prevent the adjustment in step f. from reaching 0 as a minimum reading, i.e. recorder will still write although UPPER LIMIT is reached.

i. The Alfax intensity may now be set for any desired shade of darkness without affecting the previous settings.

If Minus mode has been selected, all steps are the same as above except step d. becomes: adjust the LOWER LEVEL control until the voltmeter pointer just begins to move from minimum reading. Step f. becomes: adjust the UPPER LEVEL control until the voltmeter pointer just reaches its maximum reading. Last sentence of step g. becomes: the meter will move from a minimum to a maximum.

4. SETUP (using Simulated Signals provided by Transigraph)

a. Set the PLUS-MINUS switch to PLUS.

b. Set the SETUP-OPERATE switch to setup with UPPER LEVEL control 1/4 CW. This sets SIGNAL LEVEL meter to 0.

c. Set the CALIBRATED INPUT control to that SIGNAL LEVEL at which Alfax printing is to start.

d. Adjust the LOWER LEVEL control until the meter just reads full scale.

e. Set the CALIBRATED INPUT control to the signal level at which Alfax printing is to saturate.

f. Adjust the UPPER LEVEL control until the SIGNAL LEVEL meter just reads zero.

g. The signal levels at which Alfax printing will start and stop have now been set. These levels may now, or at any other time, be checked by rotating the CALIBRATED INPUT control from zero to full scale. The meter should begin to move when the LOWER LEVEL setting is reached, and should read 0 when the UPPER LEVEL setting is reached.

h. The Alfax INTENSITY may now be set for any desired shade of darkness without affecting the preceding settings.

i. If MINUS position is selected, all the steps are the same as above except: Step d. becomes - adjust the LOWER LEVEL control until the Transigraph SIGNAL LEVEL meter just reads zero. Step f. becomes - adjust the UPPER LEVEL control until the SIGNAL LEVEL meter just reads Full Scale. Last sentence of Step g. becomes: the meter will move from a minimum to a maximum.

NOTE

The SETUP-OPERATE switch must be in the OPERATE position while recording.

PRINCIPLES OF OPERATION

1. CONDITION

SETUP-OPERATE switch in SETUP position. PLUS-MINUS switch in PLUS position.

Refer to Block diagram (Figure 2). The right side of the differential amplifier (D. A.) on the input board is biased negatively by the 1/4 CW turn of the UPPER LEVEL control so that with the CALIBRATED INPUT at a minimum and the LOWER LEVEL control at a minimum, the output on the SIGNAL LEVEL meter is zero. Since the meter reads zero, the output transistor Q203 on amplifier board is ON and therefore output at Pin 18 J201 is 0 (See Typical Voltage Readings, paragraph 4.)

As the CALIBRATED INPUT control is rotated clockwise, a more negative voltage is applied to the grid of V101 and the D.A. remains off. As the LOWER LEVEL control is rotated clockwise, the grid of V101 goes positive and the D.A. starts conducting. Q105 conducts less, which applies a positive voltage on the grid of V102 through feedback. Q203 also conducts less and the output goes to -54V.

As the CALIBRATED INPUT is rotated toward the UPPER LEVEL, a more negative voltage is applied to the grid of V101, causing it to conduct less and Q105 to turn on more. This decreases the bias on V102 and causes it to conduct more.

This also makes the output transistor Q203 conduct more and the output goes up to about -36V.

Next the UPPER LEVEL control is rotated clockwise until the SIGNAL LEVEL meter goes to 0. The signal input to V102 goes a little more positive. This in turn gives enough signal to saturate Q105 which causes the meter to read 0. At the same time Q203 turns on fully, bringing the output to zero. As the CALIBRATED INPUT control is rotated between UPPER and LOWER LIMIT LEVELS, V101, Q105 and Q203 act as class A amplifiers and vary the output and meter linearly.

Counter clockwise rotation of the INTENSITY control decreases the input to Q201. This in turn decreases the base drive to Q205, which lowers the drive to Q203 and, therefore, its output.

2. CONDITION
SETUP-OPERATE switch in OPERATE position, PLUS-MINUS switch in plus position.

Operation is similar to operation in the setup position, except the amplitude of the gated signal on the UM Reflectoscope drives the input transistor Q204. The output of that transistor feeds one side of the D.A. as above and also feeds the meter which makes it read the input signal directly.

The input to Q204 is biased so that with no input the output is zero volts. As input signal is applied, Q204 is driven towards turnoff and its output decreases to -12 volts.

3. CONDITION
PLUS-MINUS switch in the minus position.

The left side of the D.A. is connected to ground through 100 K ohms resistor. As the input signal is increased, the grid drive of V102 goes more negative and the tube conducts a little less. Q105 and Q203 conduct

only slightly and output remains close to -60 volts.

As the LOWER LEVEL control is rotated clockwise, a more positive voltage is applied to the grid of V102, the tube conducts a little more but only sufficiently to make Q105 and Q203 conduct a little more. As the signal input is again increased, the tube is again driven a little negative. As the UPPER LEVEL control is rotated clockwise, the grid of V102 goes more positive. This causes the input to Q105 and Q203 to increase to a saturation level and the output drops to zero.

4. TYPICAL VOLTAGE READINGS

All voltages referred to ground. SETUP OPERATE switch in SETUP position.

a. PLUS-MINUS switch in PLUS position. All controls CCW except INTENSITY full CW.

Meter reads 0.9 inches.

Input	Pin 4	J101	- 7.0 V
"	" 5	"	- 7.0 V
"	" 7	"	- 7.0 V
Low level out	" 15	"	+ 14 V
Output	" 18	J201	- 14 V

b. Bring SIGNAL LEVEL meter to 0 by turning UPPER LIMIT ADJUST.

Pin 4	J101	- 7.0 V
" 5	"	- 6.8 V
" 7	"	- 6.8 V
" 15	"	0 V
" 18	J201	0 V

c. CALIBRATED INPUT adjusted to 1" lower level

Pin 4	J101	- 9.0 V
" 5	"	- 6.8 V
" 7	"	- 6.8 V
" 15	"	0 V
" 18	J201	0 V

d. LOWER LIMIT rotated clockwise until SIGNAL LEVEL meter reads 3"

Pin 4	J101	- .4 V
" 5	"	- .2 V
" 7	"	- .4 V
" 15	"	+ 54 V
" 18	J201	- 54 V

2. TRANSIGRAPH 50E543 - Chassis Inspection and Measurement.

a. Inspect chassis for loose or broken connections, loose components, signs of overheating etc.

b. Rotate all front panel controls full counter clockwise except intensity should be full clockwise.

c. PLUS-MINUS switch to PLUS.

d. OPERATE SETUP switch - SETUP.

e. Plug Servistension into STF Chassis and plug Transigraph into Servistension so that printed circuit board connectors are easily accessible.

f. Measure following voltages with VTVM or equivalent:

	J101			J201			
Pin#		Pin#		Pin #		Pin #	
1		11	- 30V DC	1	-30V DC	11	0 Grd
2		12	+ 7.5V DC	2	-60V DC	12	+ 14V DC
3	0 Grd.	13	- 12V DC	3	+ .7V DC	13	0
4	- 7V DC	14		4	+ 14V DC	14	-30V DC
5	- 7V DC	15	+ 14V DC	5	0	15	- 1.6V DC
6		16	+ 14V DC	6	0	16	+ 150V DC
7	- 7V DC	17	0 Grd	7	- 7V DC	17	0 Grd
8		18	- 30V DC	8	0	18	-14V DC
9		19	- 60V DC	9	+ 12V DC	19	-14V DC
10	+ 12V DC	20	+ 150V DC	10	- 12V DC	20	-60V DC

NOTE

The above readings are nominal values. Some deviation from these readings is normal.

BLOCK DIAGRAM

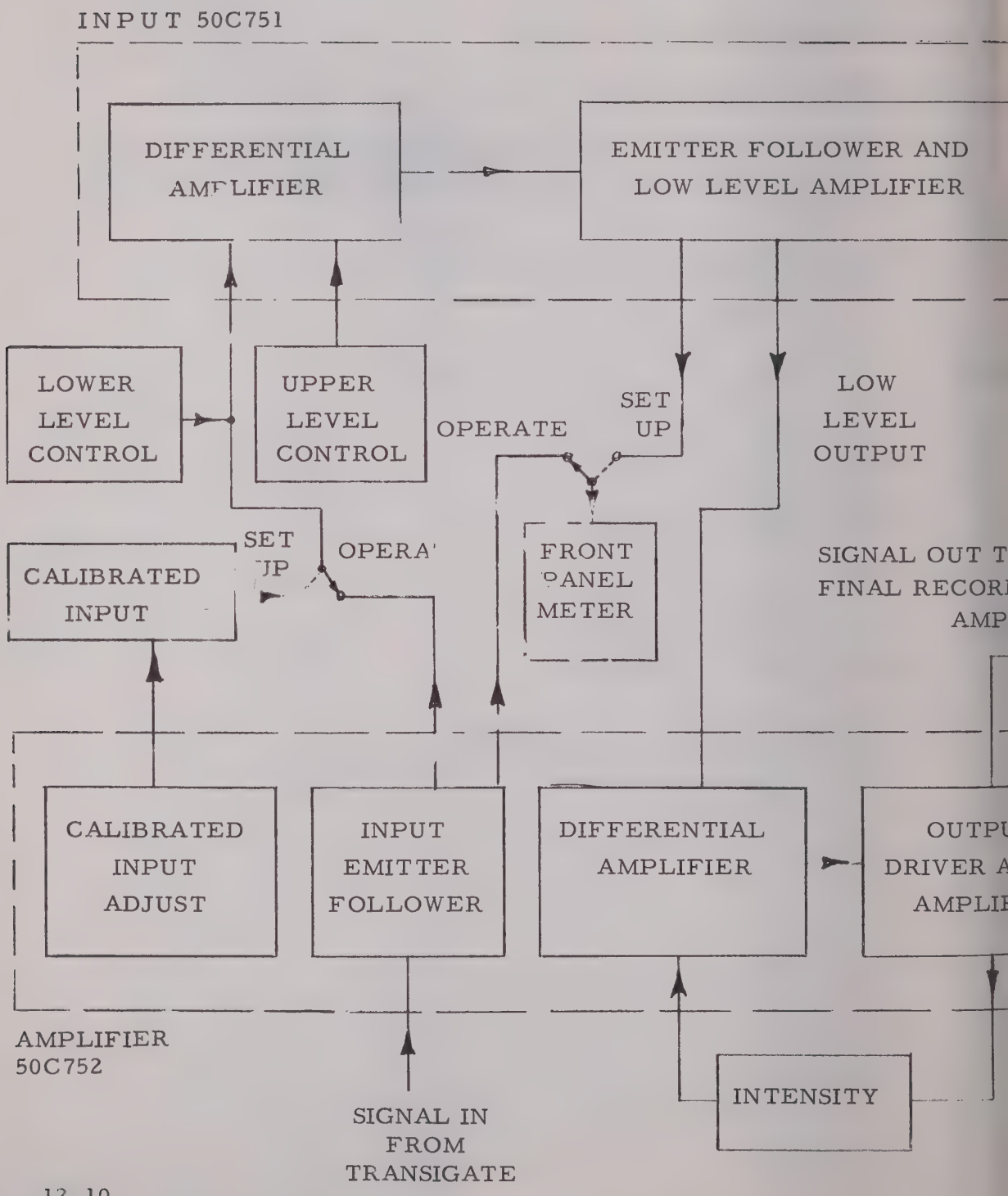

FIGURE 2.

PARTS LIST - TRANSIGRAPH UNIT

INPUT P.C. BOARD ASSEMBLY
Reference Schematic 50D341

Schematic Symbol No.	Part No.	Description
C101	Arco	Capacitor 33 uuf 500V ± 5% #DM-10-330
C103	DQG001A05	Capacitor .1 uf 200V Aerovox #P8292EN10
C104	Same as C103	
CR101	Sarkes Tarzian	Diode VR30
CR102	Same as CR101	
CR103	1N456A	Diode
CR104	Sarkes Tarzian	Diode VR56
CR105	Same as CR103	
CR106	Same as CR103	
CR107	Same as CR101	
J101	Elco	Connector #5004-20-B21-B
Q101	2N1309	Transistor
Q102	2N706	Transistor
Q103	Same as Q102	
Q104	2N1308	Transistor
Q105	2N1480	Transistor
Q106	Same as Q101	
Q107	TI494	Transistor
R101	A&B	Potentiometer Type F 1K
R102	A&B	Potentiometer Type F 50K
R103	DPA004E01	Resistor 1/2W ± 5% 100K
R104	DPA006C05	Resistor 1W ± 5% 1.5K
R105	Continental Wirt Corpn.	Resistor Pyrolytic Metal Film Type NA15 9.1K 1/2W ± 1%
R106	DPA006C21	Resistor 1W ± 5% 6.8K
R107	DPA004C24	Resistor 1/2W ± 5% 9.1K
R108	DPA004D04	Resistor 1/2W ± 5% 13K
R109	DPA004C01	Resistor 1/2W ± 5% 1K
R110	DPA004D13	Resistor 1/2W ± 5% 33K
R111	Same as R107	
R112	DPA008D23	Resistor 2W ± 5% 82K
R113	Same as R108	
R114	DPA004E13	Resistor 1/2W ± 5% 330K
R115	DPA004E01	Resistor 1/2W ± 5% 100K
R116	DPA004C17	Resistor 1/2W ± 5% 4.7K
R117	DPA004B17	Resistor 1/2W ± 5% 470 ~
R118	DPA008D05	Resistor 2W ± 5% 15K
R119	DPA004B09	Resistor 1/2W ± 5% 220 ~
R120	DPA008D15	Resistor 2W ± 5% 39K
R121	DPA004C09	Resistor 1/2W ± 5% 2.2K

Schematic Symbol No.	Part No.	Description
R123	DPA004D01	Resistor 1/2W ±5% 10K
R124	Same as R110	
V101	RCA	Nuvistor #8056
V102	Same as V101	

AMPLIFIER P. C. BOARD ASSEMBLY
Reference Schematic 50D341

C201	Sprague	Capacitor .002 uf #65 P20253
C202	Sprague	Capacitor .1 uf 250V #5HK-P10
CR201	1N456A	Diode
CR202	Same as CR201	
CR203	Same as CR201	
CR204	Sarkes Tarzian	Diode VR30
CR205	Sarkes Tarzian	Diode VR6
J201	Elco	Connector #5005-20-B21-B
Q201	2N1308	Transistor
Q202	Same as Q201	
Q203	2N1183B	Transistor
Q204	TI494	Transistor
Q205	Same as Q201	
R201	A&B	Potentiometer 250K Type F
R202	A&B	Potentiometer 50K Type F
R203	A&B	Potentiometer 1K Type F
R204	A&B	Potentiometer 10K Type F
R205	DPA004B19	Resistor 1/2W ± 5% 560 Ω
R206	DPA004D13	Resistor 1/2W ± 5% 33K
R207	DPA004D01	Resistor 1/2W ± 5% 10K
R208	Same as R207	
R209	DPA004D18	Resistor 1/2W ± 5% 51K
R210	DPA004B02	Resistor 1/2W ± 5% 110 ohms
R211	DPA004C15	Resistor 1/2W ± 5% 3.9K
R212	Same as R210	
R213	DPA004D11	Resistor 1/2W ± 5% 27K
R214	DPA004E11	Resistor 1/2W ± 5% 270K
R215	Same as R211	
R216	DPA004C01	Resistor 1/2W ± 5% 1K
R217	Same as R216	
R218	Same as R211	
R219	DPA006C11	Resistor 1W ± 5% 2.7K
R220	DPA006C13	Resistor 1W ± 5% 3.3K
R221	DPA004E24	Resistor 1/2W ± 5% 910K
R223	Same as R209	
R224	Same as R216	

FRONT PANEL ASSEMBLY
Reference Schematic 50D341

Schematic Symbol No.	Part No.	Description
C301	Aerovox	Capacitor .1 uf 200V #P8292ZN10
C302	Same as C301	
M301	50B1176	Meter
R301	DPG007H07	Potentiometer 50K
R302	DPA004C11	Resistor 1/2W ± 5% 2.7K
R303	DPG007H08	Potentiometer 25K
R304	DPA004E21	Resistor 1/2W ± 5% 680K
R305	DPA004E01	Resistor 1/2W ± 5% 100K
R306	DPA004B19	Resistor 1/2W ± 5% 560 Ω
R307	Same as R303	
R308	DPA004D17	Resistor 1/2W ± 5% 47K
R309	DPA004D15	Resistor 1/2W ± 5% 39K
R310	General Radio Co.	Potentiometer Type 971 - 1K
R311	DPA004E07	Resistor 1/2W ± 5% 180K
R312	IRC	Resistor 1/2W ± 1% 51,100 ohms 125°C Type DCC
S301	Stackpole	Switch Slide SS-34 3 PDT
S302	Same as S301	

REAR PANEL ASSEMBLY
Reference Schematic 50D341

J401	CQC017P01	Plug 26-4100-24P (Blue Ribbon)

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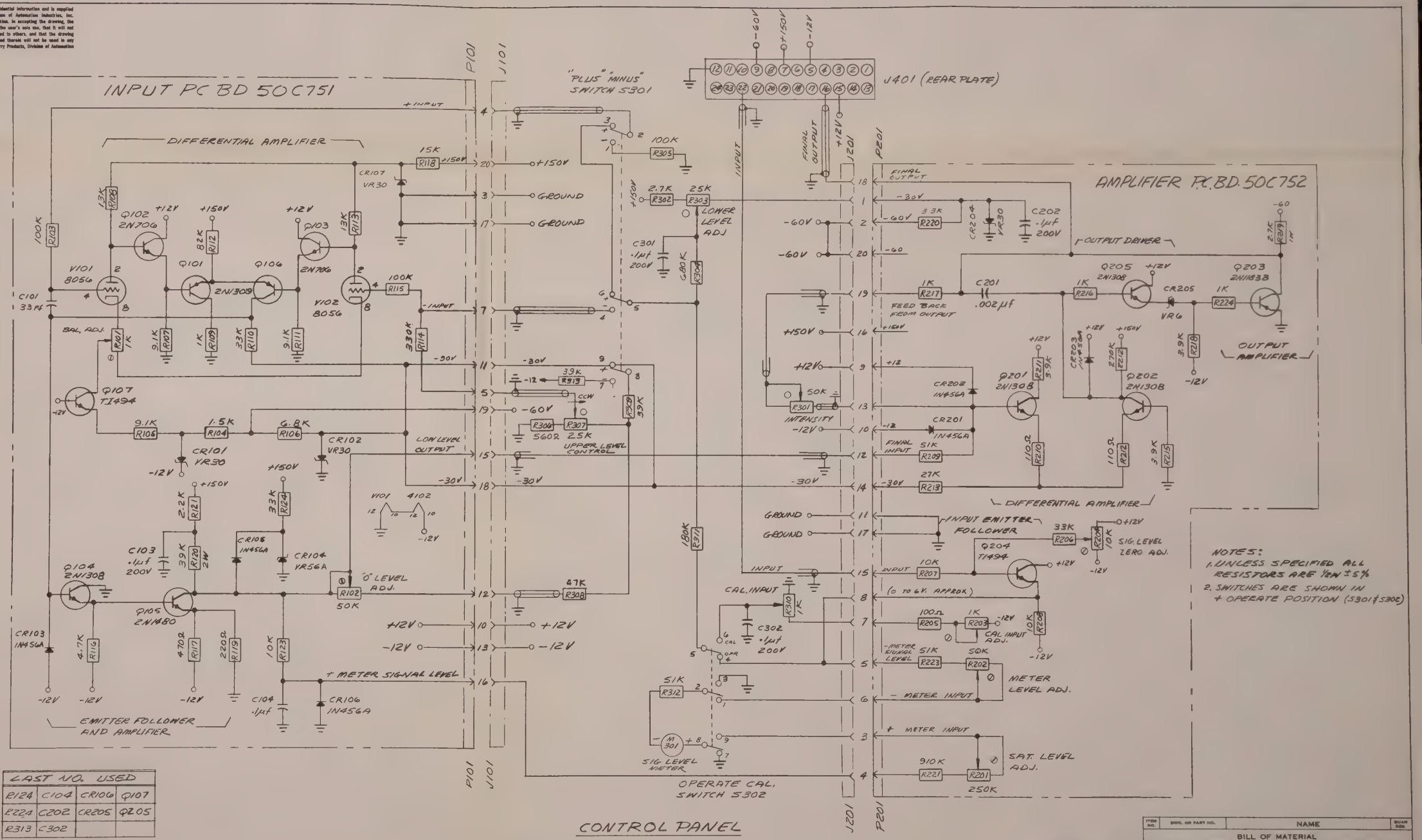


NOTES:
1. UNLESS SPECIFIED ALL RESISTORS ARE 1/2W ±5%
2. SWITCHES ARE SHOWN IN + OPERATE POSITION (S301 & S302)

LAST NO. USED			
R124	C104	CR106	Q107
E224	C202	CR205	Q205
R313	C302		

NO. NOT USED			
	C102		

ITEM NO.	DWG. OR PART NO.	NAME	QUAN REQ.
		BILL OF MATERIAL	

SCALE	50E543
EXCEPT AS NOTED	REF ASS'Y NO
DEC. ±	SPERRY PRODUCTS DIVISION OF AUTOMATION INDUSTRIES, INC. Shelton, Connecticut, U.S.A.
FRAC. ±	SCHEMATIC DIAGRAM
ANGLES ±	TRANSIGRAPH
MACH. ✓	SPERRY 50D341
MAT. OR P SPEC	GC 3-16-62
FINISH	DRAWN BY 2RW 1/7/63 · SPEC CHECK BY · DATE
ENG. REF	CHECKED BY CJR 1/7/63 · DATE
	APPROVED BY · DATE

50D341

THICKNESS READOUT UNIT
Style No. 50E568

Figure 13-1

SECTION XIII

THICKNESS READOUT UNIT
Style No. 50C568

DESCRIPTION

1. GENERAL
This unit is designed to provide an indication of thickness, using signals derived from any pulser/receiver unit. It may be plugged into the accessory space on the UM 721, or in the Special Function Chassis. Thickness is indicated by front panel meter and by strip chart recorder. It will read thickness by immersed or contact methods and requires only that signals be clearly resolved in order to provide a reading. A feature of this instrument is the ability to provide an expanded scale readout, and an alarm at any selectable thickness. As little as 10% of full scale thickness can be presented, i.e. a 1" thickness could be set to read .95" at one end of the scale and 1.05" at the other end. The readings set up on the meter will also appear on the strip chart.

2. MECHANICAL SPECIFICATIONS
The following components and controls are mounted on the front panel:

a. Meter
b. Lower Limit (knob)
c. Upper Limit (knob)
d. Lower Level (knob)
e. Upper Level (knob)
f. Gate (screw-driver control)
g. Range High-Low (switch)

3. ELECTRICAL SPECIFICATIONS
All power requirements are obtained from the UM Reflectoscope Display unit.

4. PERFORMANCE SPECIFICATIONS

a. ACCURACY
±1% of difference between upper limit and lower limit readings.

b. SCALE EXPANSION
10% to 100% of full scale.

c. RANGE
.030" to 3" in steel or aluminum. Dependent on use of a pulser/receiver to resolve these thicknesses.

d. TEST MODE
Contact, immersed, or sonic delay.

e. GATE RANGE
0-50 μsec from main bang (0 - 1.5" of water).

OPERATING INSTRUCTIONS

1. SETUP - GENERAL

a. FRONT CONNECTIONS
The Thickness Readout plugs into the accessory position on the UM721 or into a standard R or S Chassis in the UM 710 Special Function Chassis.

b. REAR CONNECTIONS
No special cables are required. When plugged into the UM721, strip chart recorder output will appear at pins 21 and 12 (ground) on J103 at the rear. In the R chassis, channel A (right side) output appears at pins 27 and 23 (ground) on J104. Channel B (left side) appears at pins 25 and 23. On the S chassis, outputs appear at pins 35 and 27 (ground) for channel A and 36 and 27 for channel B, on J104. J104 is the 36 pin connector on the panel. Output voltage will vary between +11V (lower limit) and +3V (upper limit).

2. SETUP - DETAIL

a. Warm up equipment for 15 minutes.

b. Set the range switch to low for measuring a maximum thickness under .5". Set to high for .5 to 3".

c. Set pulser/receiver controls to display signals from the maximum thickness of material to be tested. Adjust "gate" control so that start of gate displayed on CRT is to left of front surface signal. This would be main bang for contact test, and first echo signal for immersed test. With dual search unit, set gate to left of main bang.

d. Adjust receiver sensitivity so that rear surface echo is 2" or more. Gate will automatically terminate on this signal, indicating that thickness is being read between the two signals in the gated area.

e. Adjust "upper limit" control for full scale reading.

f. Test a sample of a thickness at which you wish to set the minimum scale reading. See that signal is clearly resolved and gate terminates with this signal. Adjust "lower limit" control for your reading. The minimum can be set to read zero or some scale division upscale as desired.

g. Repeat upper and lower limit adjustments until both readings are accurate.

h. A blank scale can be marked for the thickness range to be used.

i. Test a sample whose thickness equals that at which you wish the upper level alarm to operate. When reading is obtained, set the "upper level" control so alarm just lights. Repeat for "lower level". In R and S chassis, relays will operate with alarm.

j. Lock all controls.

k. Adjust recorder to display thickness readings with a known fraction of an inch per scale division so thickness can be read directly.

3. COMMENTS

a. Signals must be at least 1" to 1.5" in amplitude to produce a reading.

b. There must be a clear division between front and rear surface signals to produce a reading.

c. Changes in water path will not affect reading as long as gate remains to left of interface.

d. Check calibration against standard periodically.

e. Test frequency should be that capable of penetrating the material and resolving the thinnest section to be tested. In general, higher frequencies will give cleaner signals if signal strength is adequate. Lower frequencies will give better penetration, especially on rough or round surfaces. In this case, use the lowest frequency which permits clean resolution of the thinnest section to be measured.

PRINCIPLE OF OPERATION (Reference Schematic 50D395)

1. GATE AND RAMP GENERATOR BOARD

The Delay A is a one shot multivibrator triggered by the main sync. The trailing edge of this waveform triggers the video gate flip-flop which initiates the gate displayed on the CRT. Conduction of Q204 allows the gated amplifier to conduct, and subsequent video signals will be passed. The front surface signal will trigger the range flip-flop in one direction and the rear surface signal will trigger it in the opposite direction.

This produces a square wave of duration proportional to the thickness of the part. The trailing edge of this square wave triggers the video gate flip-flop, Q204 stops conducting, and subsequent video signals will not pass. The inverter inverts and squares up the square wave and turns on Q209. As long as Q209 is held on, Q210 conducts at a constant current, charging the high or low range capacitor. A saw tooth is produced, proportional in amplitude to the thickness of the part. This is fed to the Record Board.

2. RECORD BOARD

This is the same as the record board in the Transigate, as described on page 9-12 of the UM manual. The output at pin 16 J301 will be a DC voltage proportional to thickness. This is fed to the Alarm and Amplifier Board.

3. ALARM AND AMPLIFIER BOARD

The amplifier is a differential type which provides scale expansion by varying its gain with the lower limit control. The output from Q406 is in the same phase as the input and directly drives the meter and recorder outputs. The output is also applied to the Schmitt Triggers which fire at levels set by the level controls. These in turn fire the one shot multivibrator on the Alarm and Amplifier Board to light the alarm light on the panel and operate external relays.

WARNING

Never connect or disconnect transistorized plug-in units or P. C. Boards when UM Reflectoscope is "ON".

1. GENERAL

a. TEST AND ASSOCIATED EQUIPMENT

The following test and associated equipment is required for checking the Thickness Readout:

(1) Servistension Style 50C495

(2) Recently calibrated high input impedance (10 meg. or higher) DC Voltmeter or oscilloscope.

(3) Tektronix 515 oscilloscope or equivalent.

WARNING

Lethal voltages are present - always turn instrument off when changing components. Always keep one hand in the clear when making temporary connections (connecting test leads, etc.)

b. VOLTAGE MEASUREMENT

(1) Connect Thickness Readout unit with Servistension.

(2) Check the vollowing voltages:

Voltage	Pin #
+ 12V	1 J301
+ 12V	2 J301
+ 150V	11 J301
- 108V	17 J301

c. WAVE FORMS

(1) If trouble shooting is necessary, refer to the waveforms on the following pages.

(2) Setup for reference waveforms is:

(a) Contact test.

(b) 1 3/4" reads 100 on meter.

(c) 0" reads 0 on meter (or .25" read 14).

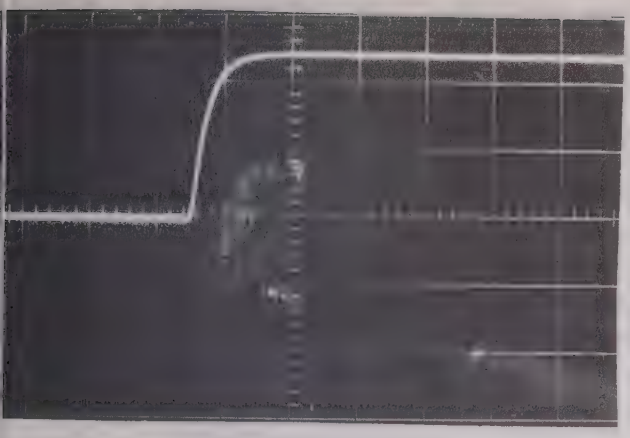
(d) All waveforms taken with 1 3/4" thickness and 100 on meter.

(e) Lower alarm level set full ccw.

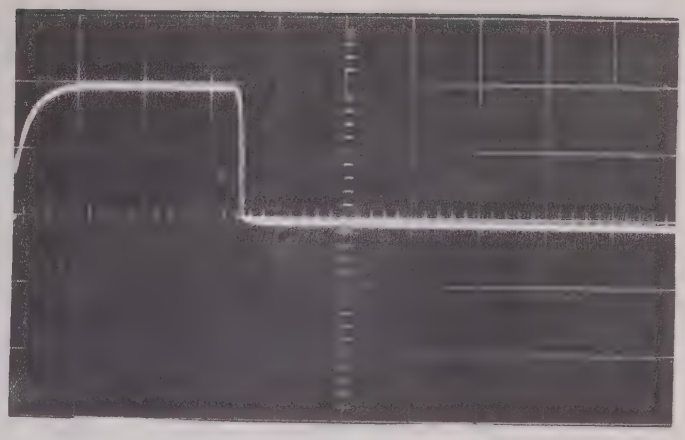
(f) Upper alarm level set full cw.

(g) 0V DC is at center scale on all pictures.

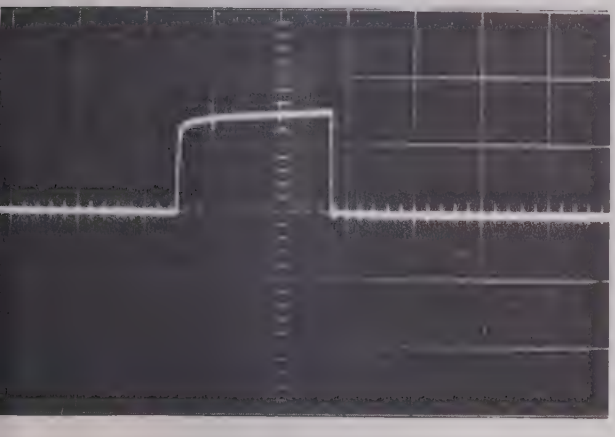
(h) Oscilloscope setup is 5V per vertical centimeter and 10 μsec per horizontal centimeter (except #12 - 100 μsec per centimeter).



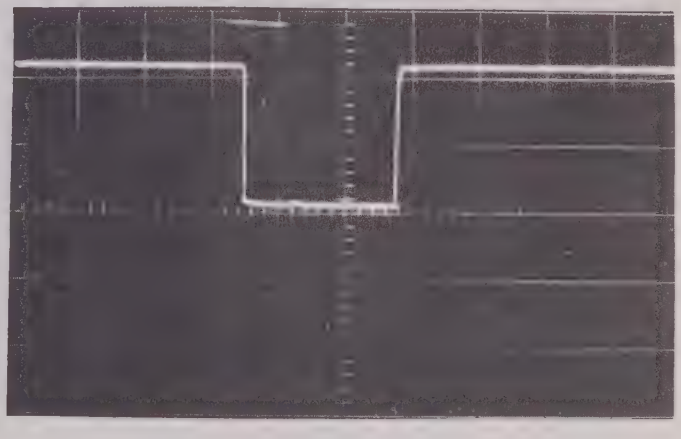
1. Collector Q201



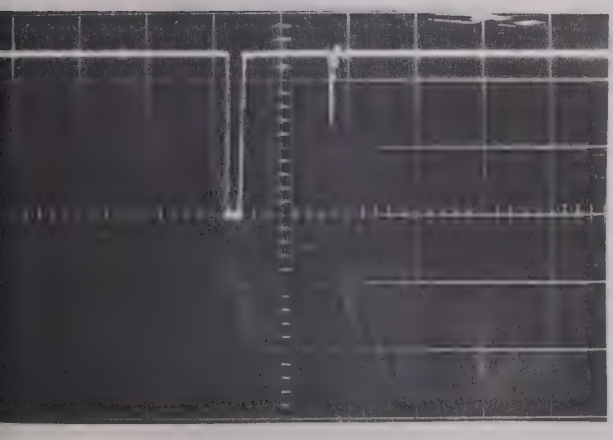
2. Collector Q202



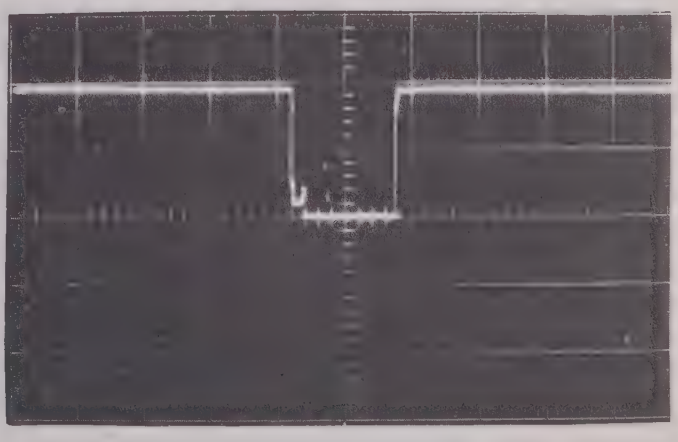
3. Collector Q203



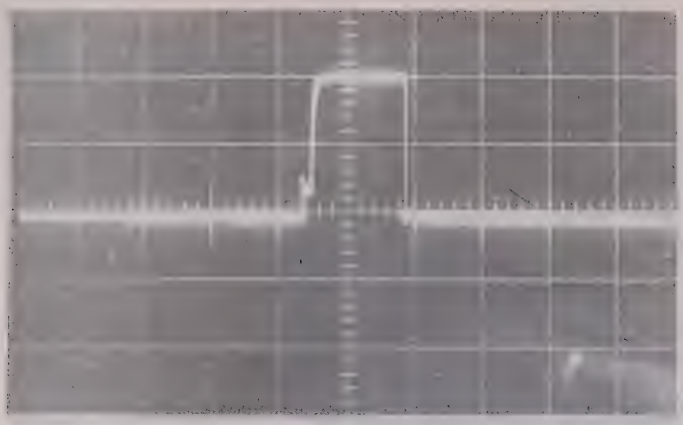
4. Collector Q204



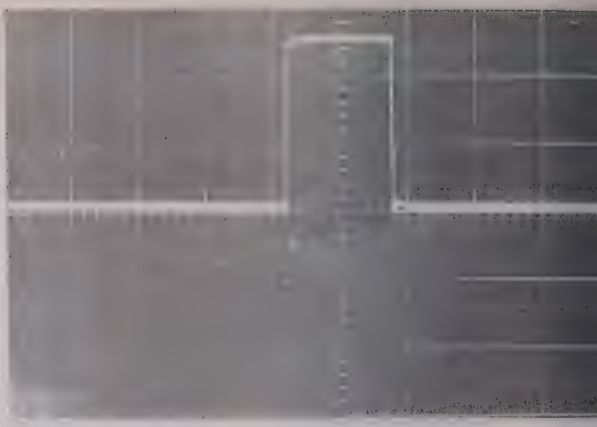
5. Collector Q205



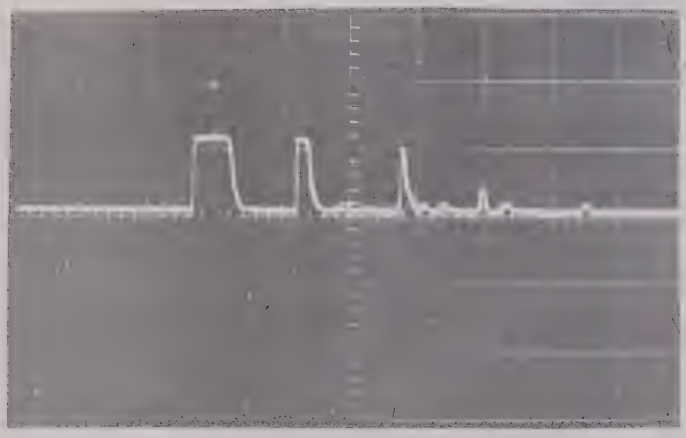
6. Collector Q206



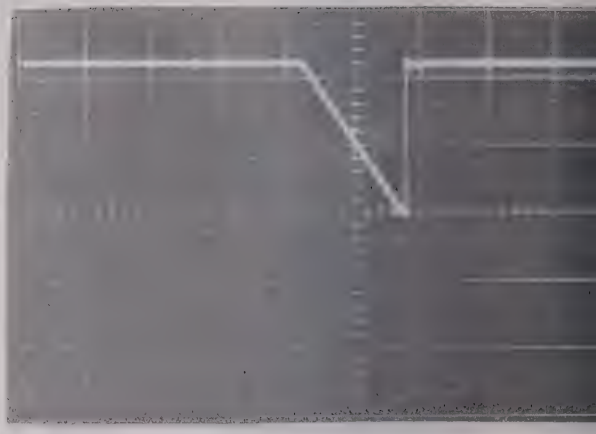
7. Collector Q207



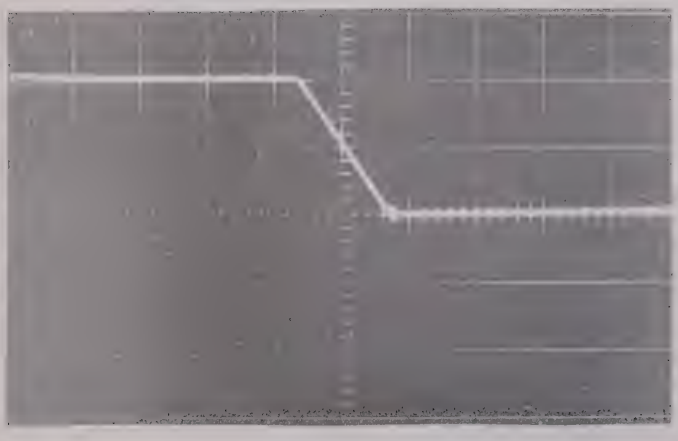
8. Collector Q208



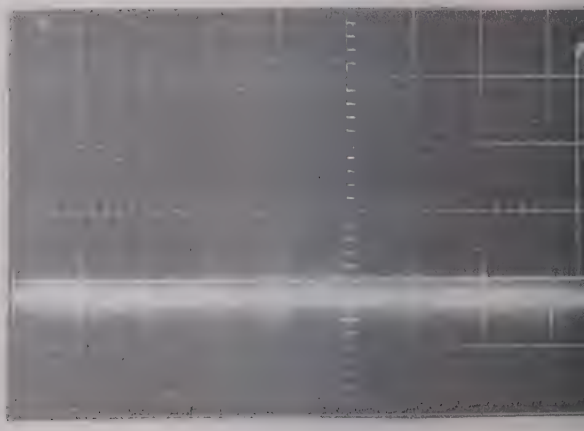
9. Pin 15 J201



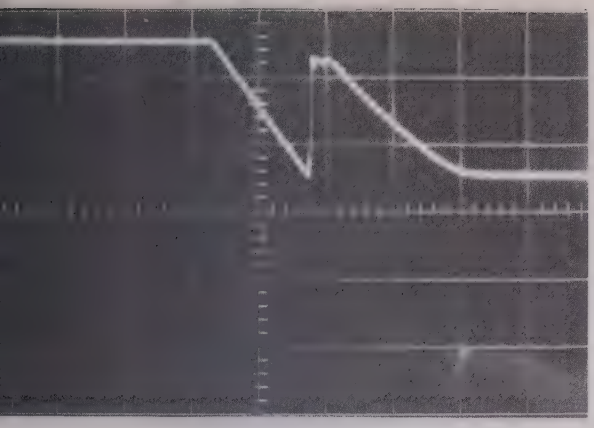
10. Pin 16 J201



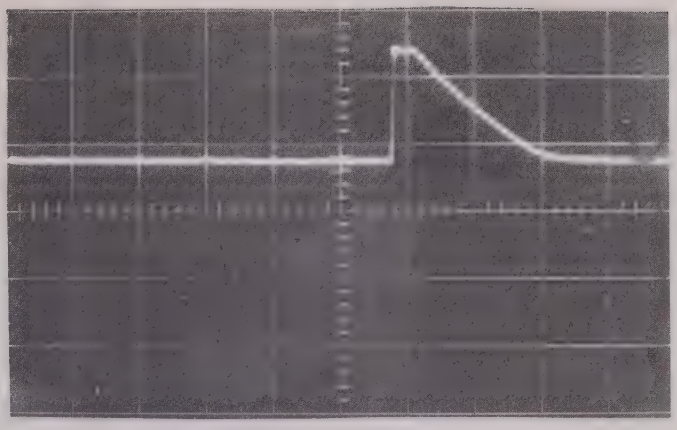
11. Emitter Q301



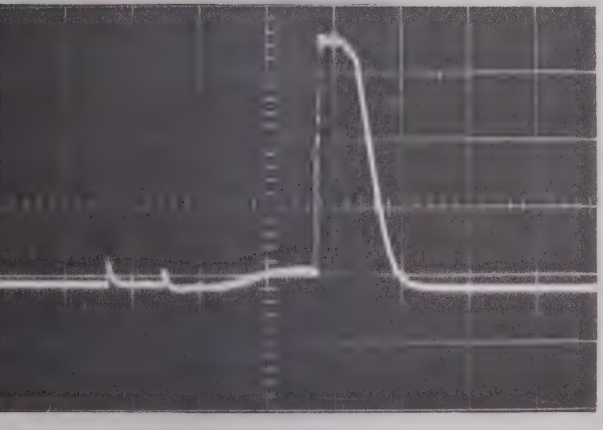
12. Colletor Q302



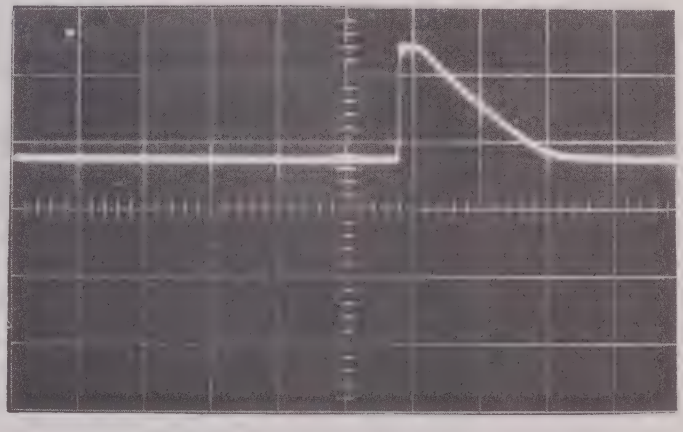
13. Cathode V301



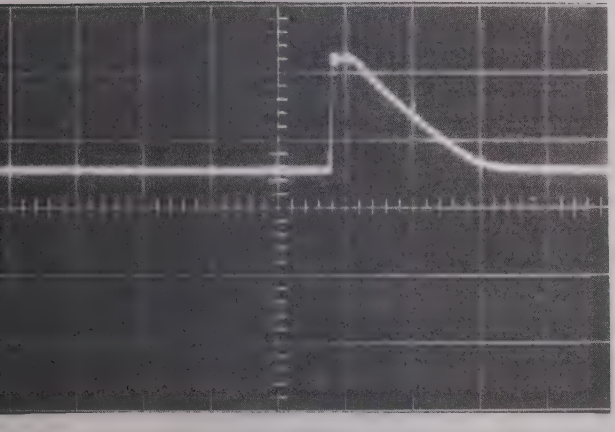
14. Pin 16 J301



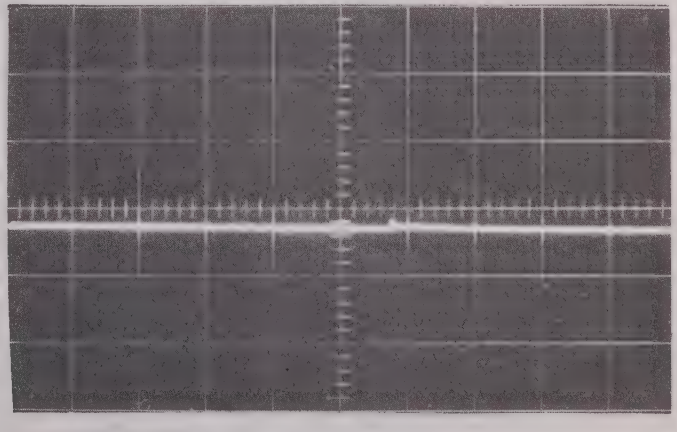
15. Collector Q307



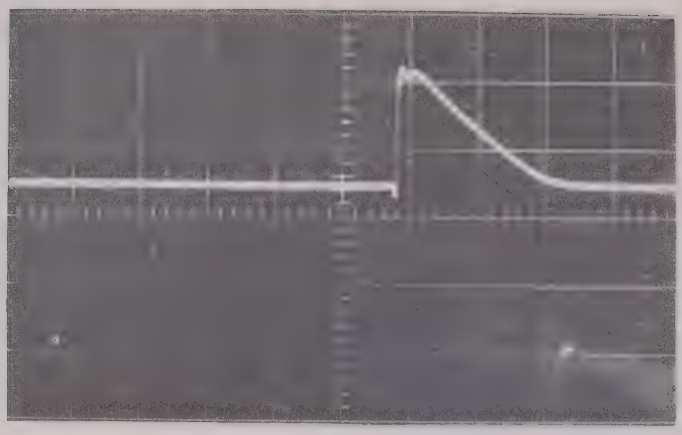
16. Base Q404



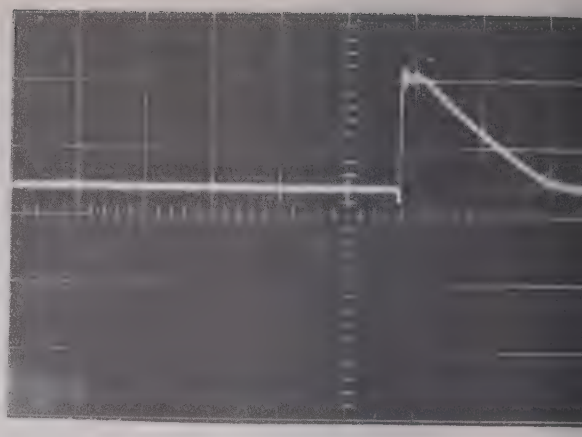
17. Emitter Q404



18. Emitter Q405



19. Collector Q405



20. Emitter Q406

PARTS LIST

THICKNESS READOUT UNIT - STYLE NO. 50E568

Reference Schematic 50D395

Schematic Symbol No.	Part No.	Description
	CHASSIS ASSEMBLY	
C101	DA104	Disc Cap Capacitor .1 mfd Sprague
C102	Same as C101	
C103	Same as C101	
C104	Same as C101	
CR101	1N1315A	Diode
CR102	Same as CR101	
CR103	1N90	Diode
CR104	1N2525	Diode
CR105	1N456	Diode
CR106	Same as CR105	
DS101	330	Lamp
J101	CQC017P01	Plug Cinch #26-4100-24P
M101	2500-2HL 001DCMA	Meter with scale changer
Q101	2N399	Transistor
R101	274-1-503M	Potentiometer 50K
R102	50A3435	Potentiometer 10K ± 30%
R103	50A3436	Potentiometer 50K ± 30%
R104	Same as R102	
R105	50A3447	Potentiometer 7.5K ± 30%
R106	DPA004A01	Resistor 10 1/2W ± 5%
R107	DPA004D02	Resistor 11K 1/2W ± 5%
S101	TS-3	Lamp
	GATE & RAMP - GENERAL P.C. BOARD ASSEMBLY	
C201	DQB005C32	Molded mica cap. - 160 pf ± 10%
C202	P83Z	.002 mf Aerovox
C203	DQB009B21	Capacitor 560 pf Arco ± 5%
C204	5C7	Disc cap. 25V .1 mf Sprague
C205	Z5U	Disc cap. .001 mf Erie

C206	DQB005C33	Capacitor 180 pf ± 10%
C207	DQB005C27	Capacitor 100 pf ± 10%
C208	DQB005C18	Capacitor 47 pf ± 10%
C209	Same as C206	
C210	Same as C207	
C211	Same as C207	
C212	DQB005C26	Capacitor 91 pf ± 10%
C213	Same as C208	
C214	DQB005C39	Capacitor 300 pf ± 10%
C215	DQB009B22	Capacitor 620 pf ± 5% Arco
C216	DQB005C37	Capacitor 250 pf ± 10%
C217	DQB005C30	Capacitor 130 pf ± 10%
C218	Same as C202	
CR201	1N270	Diode
CR202	1N914A	Diode
CR203	Same as CR202	
CR204	1N90	Diode
CR205	Same as CR202	
CR206	Same as CR202	
CR207	1N456A	Diode
CR208	Same as CR207	
CR209	1N2326	Diode
L201	2082-3	Choke 15 uh C. T. C.
Q201	2N585	Transistor
Q202	Same as Q201	
Q203	2N1308	Transistor
Q204	Same as Q203	
Q205	Same as Q203	
Q206	2N706	Transistor
Q207	Same as Q206	
Q208	Same as Q206	
Q209	2N1309	Transistor
Q210	Same as Q203	
R201	DPA004D08	Resistor 20K 1/2W ± 5%
R202	DPA004D03	Resistor 12K 1/2W ± 5%
R203	DPA004D18	Resistor 51K 1/2W ± 5%
R204	DPA004C18	Resistor 5.1K 1/2W ± 5%
R205	DPA004C01	Resistor 1K 1/2W ± 5%
R206	DPA004C13	Resistor 3.3K 1/2W ± 5%
R207	DPA004B09	Resistor 220 1/2W ± 5%
R208	DPA004C03	Resistor 1.2K 1/2W ± 5%
R209	DPA004B21	Resistor 680 1/2W ± 5%

R210	Same as R204	
R211	DPA004C24	Resistor 9.1K 1/2W ± 5%
R212	DPA004D13	Resistor 33K 1/2W ± 5%
R213	Same as R212	
R214	Same as R204	
R215	Same as R208	
R216	Same as R206	
R217	Same as R208	
R218	Same as R204	
R219	DPA004C16	Resistor 4.3K 1/2W ± 5%
R220	Same as R209	
R221	Same as R209	
R222	DPA004C15	Resistor 3.9K 1/2W ± 5%
R223	Same as R222	
R224	Same as R209	
R225	Same as R212	
R226	Same as R212	
R227	DPA004D05	Resistor 15K 1/2W ± 5%
R228	Same as R219	
R229	Same as R211	
R230	DPA004B19	Resistor 560 1/2W ± 5%
R231	Same as R202	
R232	DPA004B08	Resistor 200 1/2W ± 5%
R233	DPA004C17	Resistor 4.7K 1/2W ± 5%
R234	DPA004C08	Resistor 2K 1/2W ± 5%
R235	Same as R205	
R326	Same as R204	

RECORDER P.C. BOARD

C301	Avco	Capacitor .001 uf 600V 60P-1-102
C302	DQB005B39	Capacitor 300 uuf
C304	DQB005B33	Capacitor 180 uuf
C305	DQB005B39	Capacitor 300 uuf
C306	Erie	Capacitor 510 uuf ED-510
C307	Centralab	Capacitor .02 uf 150V DDM-203
C308	Avco	Capacitor .004 uf 600V 6DP-1-402
CR301	1N485	Diode
CR302	1N914A	
CR303	Same as CR301	
CR304	Same as CR301	
CR305	1N90	Diode
Q301	2N404	Transistor
Q302	Same as Q301	

Q303	2N404	Transistor
Q304	Same as Q303	
Q305	Same as Q303	
Q306	2N404A	Transistor
Q307	Same as Q303	
R301	DPA005B06	Resistor 270 ohms 1/2W ± 5%
R302	DPA008C119	Resistor 5.6K 2W
R303	DPA004D02	Resistor 11K 1/2W ± 5%
R304	DPA004D05	Resistor 15K 1/2W ± 5%
R305	DPA004B18	Resistor 510 ohms 1/2W ± 5%
R306	DPA004C24	Resistor 9.1K 1/2W ± 5%
R307	DPA004B18	Resistor 510 ohms 1/2W ± 5%
R308	DPA 004D04	Resistor 10K 1/2W ± 5%
R309	DPA004D19	Resistor 56K 1/2W ± 5%
R310	DPA004D10	Resistor 24K 1/2W ± 5%
R311	DPA004B24	Resistor 910 ohms 1/2W ± 5%
R312	DPA004D17	Resistor 47K 1/2W ± 5%
R313	Same as R312	
R314	Same as R308	
R315	DPA005C10	Resistor 5.6K 1/2W ± 5%
R316	DPA004E05	Resistor 150K 1/2W ± 5%
R317	DPA004C07	Resistor 1.8K 1/2W ± 5%
R318	DPA004C08	Resistor 2K 1/2W ± 5%
R319	DPA004E22	Resistor 750K 1/2W ± 5%
R320	DPA004C15	Resistor 3.9K 1/2W ± 5%
R321	Same as R310	
R322	Same as R308	
R323	DPA004E23	Resistor 820K 1/2W ± 5%
R324	DPA007D10	Resistor 56K 1/2W ± 5%
R325	Same as R308	
R326	Same as R308	
R327	DPA004D13	Resistor 33K 1/2W ± 5%
V301	6CW4	Tube
V302	Same as V301	
	Elco	Transistor Socket 3303
	Cinch-Jones	Tube Socket 133 65101001
	50B807	Recorder P.C. Board Sub-Assembly

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GATE & RAMP GEN. PC BD 50C946

DELAY & ONE SHOT | VIDEO GATE FLIP FLOP | GATED AMPLIFIER | RANGE FLIP FLOP | INVERTER | RAMP GEN.

AMPLIFIER | EMITTER FOLLOWER

SCHMITT TRIGGER

ONE SHOT MULTIVIBRATOR

ALARM & AMP PC BD 50C945

RECORD PC BD 50B1333

E.F. | E.F. | RESET AMP. | C.F. | C.F. | RESET AMP. | SCHMITT TRIGGER

RECORDER OUTPUT | RAMP OUTPUT | RAMP INPUT | SYNC | GATE DISPLAY | VIDEO

J101 | J201 | J301 | J401 | 5101

NOTE
1. UNLESS SPECIFIED
a RESISTORS ARE ½W ±5%
b CAPACITORS ARE PF

LAST NO USED			
R239	C218	CR209	Q210
R325	C306	CR304	Q307
R336	C405	CR406	Q409
	C105	CR104	Q101

NO'S NOT USED	
R310	CR404
R401	C208
R423	C209
	L201

ITEM NO.	DWG. OR PART NO.	NAME	QUAN REQ.
		BILL OF MATERIAL	

LTR.	ENG. REP.	DATE	ECN. NO.	CHK
C	70-70	6-17-64	7245	RL
A	6818	11-3-64		

SCALE —— EXCEPT AS NOTED | DEC. ± | FRAC. ± | ANGLES ± | MACH. ✓ | MAT. OR P. SPEC. | FINISH

50E568 REF. ASS'Y. NO.

SPERRY PRODUCTS
DIVISION OF AUTOMATION INDUSTRIES, INC.
Danbury, Connecticut, U.S.A.

SCHEMATIC
THICKNESS READOUT
SPERRY 50D395

DRAWN BY GC 10-20-64 | DATE | MFG CHECK BY | DATE
CHECKED BY RL 11-3-64 | DATE
APPROVED BY | DATE

50D395